

Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.



United States
Department of
Agriculture

Cooperative State
Research, Education
and Extension Service

Office of
Grants and
Program Systems

SBIR-96-1

2HD2396
U5P76

Program Solicitation

S

Small Business Innovation Research Program

Fiscal Year 1996

Closing Date: September 14, 1995

NATIONAL SBIR CONFERENCES

*FEDERAL R&D OPPORTUNITIES FOR
TECHNOLOGY INTENSIVE FIRMS*

SPONSORED BY:

*DEPARTMENT OF DEFENSE
AND
NATIONAL SCIENCE FOUNDATION*

*In Cooperation with All Federal SBIR Departments
and Agencies*

R&D and Technology Marketing Opportunities to 11 Federal Agencies and 20 Major Corporations.

Keynote Speakers and Special Sessions on Commercializing R&D, Joint Ventures, Strategic Alliances, Licensing, International Markets.

Seminars in 20 Special Areas Important to Small Technology Firms, Including Procurement, Audit, Finance, Accounting, Proposal Preparation, Starting and Financing the Small High Tech Firm.

Come and Meet 125 Experts in these Areas.

EAST	WASHINGTON, DC	OCTOBER 16-18, 1995
WEST	SALT LAKE CITY, UT	OCTOBER 30-NOVEMBER 1, 1995
MID-WEST	DALLAS, TX	APRIL 29-MAY 1, 1996

FOR REGISTRATION OR FURTHER INFORMATION

Hotline (407) 791-0720

CONTENTS

	Page
1.0 General Program Description	1
1.1 Introduction	1
1.2 Three-phase Program	1
1.3 Follow-on Funding	2
1.4 Eligibility and Limitations	3
2.0 Definitions	3
2.1 Research or Research and Development	3
2.2 Small Business	3
2.3 Principal Investigator	4
2.4 Socially and Economically Disadvantaged Small Business Concern	4
2.5 Women-owned Small Business	4
2.6 United States	4
2.7 Program Solicitation	4
2.8 Subcontract	4
2.9 Funding Agreement	4
2.10 Commercialization	4
3.0 Proposal Preparation Instructions and Requirements	5
3.1 Proposal Requirements	5
3.2 General Content	5
3.3 Proposal Format	5
4.0 Method of Selection and Evaluation Criteria	9
4.1 Introduction	9
4.2 Initial Screening Criteria	9
4.3 Phase I Evaluation Criteria	10
4.4 Phase II Evaluation Criteria	10
4.5 Notice to Proposers	11
5.0 Considerations	11
5.1 Awards	11
5.2 Reports	11
5.3 Payment Schedules	12
5.4 Proprietary Information	12
5.5 Rights in Technical Data	12
5.6 Copyrights	13
5.7 Patents and Inventions	13
5.8 American-made Equipment and Products	13
5.9 Cost Sharing	13
5.10 Profit or Fee	13
5.11 Joint Ventures and Limited Partnerships	13
5.12 Research and Analytical Work	13
5.13 Research Involving Special Considerations	13
5.14 Grantee Commitments	14
5.15 Additional Information	14
6.0 Submission of Proposals	21
6.1 Deadlines for Proposals	21
6.2 Number of Copies	21
6.3 Address	21
6.4 Acknowledgment of Proposals	22
6.5 Bindings	22

USDA
NAT'L. AGRIC. LIBRARY
1995 JUL 24 P 1:11
CURRENT SERIAL RECORDS
ACO/SERIALS BRANCH

6.6	Packaging	22
6.7	Questions Pertaining to the USDA SBIR Program or to this Solicitation	22
6.8	Requests for Additional Copies of this Solicitation	22
6.9	Information on Proposal Status	22
7.0	Scientific and Technical Information Sources	22
8.0	Research Topic Descriptions	23
8.1	Forests and Related Resources	23
8.2	Plant Production and Protection	24
8.3	Animal Production and Protection	24
8.4	Air, Water, and Soils	25
8.5	Food Science and Nutrition	25
8.6	Rural and Community Development	26
8.7	Aquaculture	27
8.8	Industrial Applications	27
8.9	Marketing and Trade	28
9.0	Submission Forms and Certifications	31
9.1	Proposal Cover Sheet (Phases I and II)	31
9.2	Project Summary (Phases I and II)	33
9.3	Budget	35
9.4	Assurance Statement(s)	37
9.5	National Environmental Policy Act Exclusions Form	39
10.0	Sample Proposal	41

Please note that the text of the proposal should be prepared using no type smaller than 11 point font size regardless of whether it is single or double spaced.

USDA'S PROGRAM SOLICITATION SMALL BUSINESS INNOVATION RESEARCH FISCAL YEAR 1996

1.0 GENERAL PROGRAM DESCRIPTION

1.1 Introduction

The U.S. Department of Agriculture (USDA) invites science-based small business firms to submit research proposals under this program solicitation entitled "Small Business Innovation Research Program, Fiscal Year 1996." Firms with strong scientific research capabilities in any of the topic areas described in section 8.0 are encouraged to participate. USDA will support high-quality research or research and development (R&D) proposals containing advanced concepts related to important scientific problems and opportunities that could lead to significant public benefit if the research is successful.

Objectives of the Small Business Innovation Research (SBIR) program include stimulating technological innovation in the private sector, strengthening the role of small businesses in meeting Federal research and development needs, increasing private sector commercialization of innovations derived from USDA-supported research and development efforts, and fostering and encouraging participation by women-owned and socially and economically disadvantaged small business firms in technological innovation. Questions of a general nature about this SBIR solicitation should be directed to:

Dr. Charles F. Cleland
Director, SBIR Program
Cooperative State Research, Education, and
Extension Service
U.S. Department of Agriculture
Ag Box 2243
Washington, D.C. 20250-2243
Telephone: (202) 401-4002

1.2 Three-phase Program

NOTE: This program solicitation is primarily for the preparation and submission of phase I proposals. However, the solicitation is also applicable for those preparing phase II proposals, for it contains the necessary forms for proposal submission, delineates the evaluation criteria that will be used, and provides other relevant information. More detailed guidance on phase II proposal preparation will be provided by the Director, SBIR Program, in a letter that is sent out in the Fall of each year to phase I awardees.

This program solicitation is issued pursuant to the Small Business Innovation Development Act of 1982, Public Law 97-219, as amended (15 U.S.C. 638) and Section 630 of the Act making appropriations for Agriculture, Rural Development, and Related Agencies' programs for fiscal year ending September 30, 1987, and for other purposes, as made applicable by Section 101(a) of Public Law 99-591, 100 Stat. 3341. This program is administered by the Cooperative State Research, Education, and Extension Service (CSREES) of the USDA. (The CSREES was established by Section 251(d)(1) of Public Law 103-354, the Federal Crop Insurance Reform and Department of Agriculture Reorganization Act of 1994, and the functions of the Cooperative State Research Service were transferred to the CSREES by Section 2.b(7) of the Secretary of Agriculture's Memorandum 1010-1, dated October 20, 1994.)

This program is subject to the provisions found at 7 CFR Part 3403 (53 FR 21966, June 10, 1988, as amended by 56 FR 47882, September 20, 1991). These provisions set forth procedures to be followed when submitting grant proposals, rules governing the evaluation of proposals and the awarding of grants, and regulations relating to the post-award administration of grant projects.

The program will be carried out in three separate phases. Under phase I, USDA anticipates making approximately 75 awards to small businesses during fiscal year 1996, with each award ranging up to \$55,000 for a period normally not to exceed 6 months. See subsection 4.2(E) regarding phase I projects requiring a longer grant period than 6 months. Phase I is to determine the scientific or technical feasibility of ideas submitted by proposers on research topic areas described in section 8.0 of this solicitation. The phase I proposal should concentrate on research which will significantly contribute to **proving the scientific or technical feasibility** of the approach or concept and which would be a prerequisite to further USDA support in phase II.

Phase II awards will be made during fiscal year 1996 to firms with approaches that appear sufficiently promising as a result of phase I studies. **Only those small businesses previously receiving phase I awards in either fiscal years 1994 or 1995 are eligible to submit phase II proposals in fiscal year 1996. Please note, however, that for each phase I project funded the awardee may**

apply for a phase II award only once. Proposals for phase II may only be submitted to the Federal agency from which the phase I award was received.

Phase I awardees in fiscal year 1995 who are unable to submit phase II proposals for valid reasons during the fiscal year 1996 funding cycle, will be eligible to apply for phase II support no later than the fiscal year 1997 funding cycle. One reason for not submitting the phase II proposal during the fiscal year 1996 funding cycle would be one which precludes completion of the phase I project within the designated award period. In such instances, the awardee must request in writing, prior to the end of the phase I grant period, a no-cost extension from the Director, SBIR Program, outlining the circumstances which prevent completion of the project. Once the no-cost extension request is approved, any remaining Federal funds may be expended on the project in accordance with the approved budget within the extended award period.

Phase II projects are limited to \$250,000, with the average award being about \$200,000, for a period normally not to exceed 24 months. It is anticipated that approximately one-half of phase I awardees will receive phase II grants, depending upon phase I results, the scientific and technical merit of the phase II proposal, and the availability of funds. Phase II is the principal research or research and development effort and will require a more comprehensive application, outlining the proposed effort in detail. At the appropriate time, the Director, SBIR Program will send a letter to all eligible phase I awardees requesting phase II proposals. The letter will provide instructions for preparing phase II proposals and a deadline date (normally February 15 of each year) for submitting applications. USDA recognizes that phase II awards may not be sufficient in either dollars or time for the firm to complete the total research and development required to bring the project results to commercialization in the market place. Therefore, completion of the research under these circumstances may necessarily have to be carried into phase III, the commercialization phase.

The purpose of phase III is to stimulate technological innovation and the national return on investment from research through the pursuit of commercialization objectives resulting from the USDA-supported work carried out in phases I and II. No Federal SBIR funds may be used to support phase III projects. However, firms are strongly encouraged to secure phase III funding from their own resources or from other public and private sources of funds. Additionally, phase III is to be conducted by the small business concern (including joint ventures and limited partnerships).

1.3 Follow-on Funding

In addition to supporting scientific research and development, another important goal of this program is to provide incentive and opportunity for small firms to convert USDA-sponsored research to technological innovation in the private sector. All proposed research should have some potential commercial outcome, and applicants are encouraged to obtain a contingent commitment for non-SBIR follow-on funding to pursue further development of the commercial potential during phase III. Government funding pays for research relating to Federal objectives (phases I and II); non-SBIR (public or private) funding pays for development of commercial objectives (phase III).

Obtaining follow-on financial commitment(s) is the responsibility of the proposer. USDA understands that any such commitment will likely be contingent upon the awardee attaining technical objectives that are mutually agreed upon between the small business and the provider of the follow-on funding. These objectives should be closely related to those delineated in the phase II research proposal. The technical objectives should be clearly defined and measurable, and should be specified in the commitment agreement at the threshold level that would justify such an investment. The objectives do not have to be identical to those stated in the phase II proposal, but they must be able to be accomplished within the scope of the proposed SBIR-funded research. Any letters or other forms of tentative commitment for follow-on phase III funding from sources other than Federal SBIR Programs, will be considered.

Phase I proposals should contain a brief description of any potential commercial application(s) and whether or not the small business will attempt to secure follow-on, non-SBIR funding to pursue the commercial development of the expected products from the proposed research. In order for phase II proposers to receive consideration of follow-on funding during the review and evaluation process, a signed contingent commitment between the small business and the entity providing the follow-on financial support should be submitted with the phase II application. While such commitment agreements are optional when submitting phase II proposals, they will receive special consideration as a point of merit in the review and evaluation process where proposals are evaluated as being of approximately equal technical merit. **The maximum value (in phase II evaluation) will be given for a signed formal agreement with reasonable terms and funding equal to or in excess of the Federal investment requested in the phase II proposal.** The agreement should set forth the specific amount of phase III funds and should indicate the dates that such funds will be made available to the small business. Also, the

agreement should contain a few specific technical objectives which, if achieved in phase II, will make the commitment usable by the small business. The terms cannot be contingent upon the obtaining of a patent, due to the length of time this process requires.

The commitment may be in the form of venture capital or a package including venture capital, contract research and development, a joint venture, a research and development limited partnership, or other agreement with a non-SBIR source of funding. No amortization, repayment, or repurchase of commitment funds may be included during the phase II period of performance.

1.4 Eligibility and Limitations

Each organization submitting a proposal must qualify as a small business for research purposes, must be the primary employer of the principal investigator at the time of award and during the conduct of the actual research, and must be the primary performer of the research and development effort (see definitions in section 2.0). In addition, for both phase I and phase II, the work must be performed by the small business concern in the United States.

A joint venture or a limited partnership is eligible to submit a proposal provided that the entity created qualifies as a small business in accordance with section 2[3] of the Small Business Act, 15 U.S.C. 632, and the definition found at subsection 2.2 of this solicitation.

2.0 DEFINITIONS

The following definitions apply for purposes of this solicitation:

2.1 Research or Research and Development

Research or research and development (R&D) means any activity which is:

- (A) A systematic, intensive study directed toward greater knowledge or understanding of the subject studied;
- (B) A systematic study directed specifically toward applying new knowledge to meet a recognized need; or
- (C) A systematic application of knowledge toward the production of useful materials, devices, and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements.

2.2 Small Business Concern

A small business concern means a concern which **at the time of award** of phase I and phase II funding agreements meets the following criteria:

- (A) Is organized for profit, independently owned or operated, is not dominant in the field in which it is proposing, has its principal place of business located in the United States, has a number of employees not exceeding 500 (full-time, part-time, temporary, or other) in all affiliated concerns owned or controlled by a single parent

concern, and meets the other regulatory requirements outlined in 13 CFR Part 121. Business concerns, other than licensed investment companies or State development companies qualifying under the Small Business Investment Act of 1958, 15 U.S.C. 661, et seq., are affiliates of one another when directly or indirectly (1) one concern controls or has the power to control the other; or (2) third parties (or party) control or have the power to control both. Control can be exercised through common ownership, common management, and contractual relationships. The term “affiliates” is defined in greater detail in 13 CFR 121.401(a). The term “number of employees” is defined in 13 CFR 121.407. Business concerns include, but are not limited to, any individual, partnership, corporation, joint venture, association, or cooperative.

- (B) Is at least 51 percent owned or, in the case of a publicly owned business, at least 51 percent of its voting stock is owned by United States citizens or lawfully admitted permanent resident aliens.
- (C) Is the primary source of employment of the principal investigator of the proposed effort **at the time of award** and during the conduct of the proposed research. Primary employment means that more than one-half of the principal investigator’s time is spent in the employ of the small business. Primary employment with the small business applicant precludes full-time employment with another organization. This requirement applies to both phase I and phase II awards. If the proposed principal investigator is

employed by another organization (e.g., university or another company) at the time of submission of the application, **documentation must be submitted with the proposal from the principal investigator's current employer verifying that, in the event of an SBIR award, he/she will become a less than half-time employee of such organization and will remain so for the duration of the SBIR project.**

- (D) Is the primary performer of the proposed research effort. A minimum of **two-thirds** of the research or analytical work, as determined by budget expenditures, must be performed by the proposing organization under **phase I grants**. For **phase II awards**, a minimum of **one-half** of the research or analytical effort must be conducted by the proposing firm. For both phase I and phase II the research must be performed in the United States. **The space used by the SBIR awardee to conduct the research must be space over which it has exclusive control for the period of the grant.**

2.3 Principal Investigator

The individual designated by the applicant to be principally responsible for the scientific or technical direction of the work described in a proposal. Therefore, the individual should have a scientific/technical background.

2.4 Socially and Economically Disadvantaged Small Business Concern

A socially and economically disadvantaged small business concern is one:

- (A) Which is at least 51 percent owned by (i) an Indian tribe or a native Hawaiian organization, or (ii) one or more socially and economically disadvantaged individuals; and
- (B) Whose management and daily business operations are controlled by one or more socially and economically disadvantaged individuals.

For purposes of this solicitation, a socially and economically disadvantaged individual is defined as a member of any of the following groups: Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, Subcontinent Asian Americans, other groups designated from time to time by the Small Business Administration (SBA) to be socially disadvantaged, or any other individual found to be socially and economically disadvantaged by the SBA pursuant to section 8(a) of the Small Business Act, 15 U.S.C. 637(a).

Note: The certification of socially and economically disadvantaged small business at 9.1 is for statistical purposes only.

2.5 Women-owned Small Business Concern

Women-owned small business concern means a small business concern that is at least 51 percent owned by a woman or women who also control and operate it. "Control" as used in this context means exercising the power to make policy decisions. "Operate" as used in this context means being actively involved in the day-to-day management of the concern.

Note: The certification of women-owned small business at 9.1 is for statistical purposes only.

2.6 United States

United States means the several states, the territories and possessions of the United States, the Commonwealth of Puerto Rico, the Trust Territory of the Pacific Islands, and the District of Columbia.

2.7 Program Solicitation

A program solicitation is a formal request for proposals whereby an agency notifies the small business community of its research or R&D needs and interests in selected areas and invites proposals from small business concerns in response to these needs and interests.

2.8 Subcontract

A subcontract is any agreement, other than one involving an employer-employee relationship, entered into by a Federal Government funding agreement awardee calling for supplies or services required solely for the performance of the original funding agreement.

2.9 Funding Agreement

A funding agreement is any contract, grant, or cooperative agreement entered into between any Federal agency and any small business for the performance of experimental, developmental or research work funded in whole or in part by the Federal Government.

2.10 Commercialization

Commercialization is defined as the process of developing markets and producing and delivering products for sale (whether by the originating party or by others); as used here, commercialization includes both government and commercial markets.

3.0 PROPOSAL PREPARATION INSTRUCTIONS AND REQUIREMENTS

3.1 Proposal Requirements

This is a solicitation for **phase I research proposals on advanced concepts** from small businesses which have strong research capabilities in the basic and applied sciences.

The proposed research must be responsive to one of the USDA program interests stated in the research topic descriptions of this solicitation. However, the USDA does not prioritize between research topics or between different research objectives within a specific research topic. Thus, the specific research objectives proposed by applicants are investigator-initiated and not initiated by the USDA, and applicants are free to propose any research project that fits within one of the nine research topics listed in 8.0. The same research can often be the basis for technological innovation, new commercial products, processes, or services which benefit the public. This is a desirable economic objective, and such proposals are encouraged.

Proposals must cover only scientific research activities. **A small business must not propose technical assistance, demonstration projects, classified research, or patent applications.** Many of the research projects supported by the SBIR program lead to the development of new products based upon the research results obtained during the project. However, projects that seek funding solely for product development where no research is involved, i.e. the funds are needed to permit the development of a product based on previously completed research, will not be accepted.

Literature surveys and appropriate discussions should be included in the research proposal and should not be proposed as a part of the SBIR phase I or phase II effort. Proposals that deal principally with developing proven concepts for commercial markets or scaling up previously developed prototypes for commercial production should not be submitted, since such efforts are considered the responsibility of the private sector and therefore are not supported by USDA.

A proposal must be limited to only one topic, the title of which must be entered on the cover sheet of the application. The same proposal may not be submitted under more than one topic. However, an organization may submit separate proposals on different topics or

different proposals on the same topic under this solicitation. Where similar research is discussed under more than one topic, the proposer should choose that topic whose description appears most relevant to the proposer's research concept. Proposers may respond to any of the topics listed under section 8.0 below. Research may be carried out through the construction and evaluation of a laboratory prototype, where necessary. **Duplicate proposals will be returned to the applicant without review.**

The purpose of a research proposal is to provide a written statement that contains sufficient information to persuade members of the research community who review the proposal and then advise the USDA SBIR professional staff that the proposed research is a sound approach to an important scientific question and is worthy of support under the stated USDA evaluation criteria (see section 4.0). The proposal should be self-contained and written with the care and thoroughness accorded papers for publication. Each proposal should be reviewed carefully by the applicant and by others knowledgeable on the subject to ensure inclusion of data essential for comprehensive evaluation.

The primary evaluation criteria is the scientific or technical merit of the proposed research. **The quality of the research proposal will be the principal basis upon which all proposals will be evaluated and selected for funding.**

3.2 General Content

This solicitation is designed to reduce the investment of time and cost to small business concerns in preparing formal proposals. Those who wish to respond should submit a research proposal of **no more than 25 pages**, including cover page, budget, and all **proposal-related** enclosures or attachments. The text must be prepared on only one side of the page using standard size (8 1/2" x 11"; 21.6 cm x 27.9 cm) white paper, with no type smaller than 11 point font size regardless of whether it is single or double spaced. In the interest of equity to all proposers, no additional attachments, appendixes, or references beyond the 25-page limitation will be considered in the proposal evaluation process, and proposals in excess of the 25-page limitation will not be considered for review or award. In addition, supplementary materials, **revisions, and/or substitutions will not be accepted after the due date for proposals.** Phase II applicants should

submit a research proposal of no more than 50 pages, including cover page, budget, and all proposal-related enclosures or attachments.

It is not necessary to provide a lengthy discourse on commercial applications in the phase I proposal except to discuss them briefly under subsection 3.3(C), as appropriate, as well as under subsection 3.3(G). The phase I proposal must be principally directed at feasibility-related research or R&D on the specific topic chosen.

3.3 Proposal Format

(A) **Cover Sheet** - Photocopy and complete Form CSRS-667 (9.1) and use it as page 1 of the proposal. All pages must be consecutively numbered. The original of the cover sheet must at a minimum contain the pen-and-ink signatures of the proposed principal investigator(s) and the authorized organizational official. A submitting principal investigator whose signature does not appear on the cover sheet will not be listed as a principal investigator in the event of an award. A proposal which does not contain the signature of the authorized organizational official will not be considered a legal document and will be returned to the proposing small business without review. All other copies of the proposal must also contain a cover sheet but facsimile or photocopied signatures will be accepted. The title should be a brief (80-character maximum), clear, specific designation of the research proposed. It will be used to provide information to Congress and also will be used in issuing press releases. Therefore, it should not contain highly technical words. In addition, phrases such as "investigation of" or "research on" should not be used.

(B) **Project Summary** - Photocopy and complete Form CSRS-668 (9.2) and use it as page 2 of the proposal. The technical abstract should include a brief description of the problem or opportunity, project objectives, and a description of the effort. Anticipated results and potential commercial applications of the proposed research also should be summarized in the space provided. Key words, to be provided in the last block on the page, should characterize the most important aspects of the project.

The information contained on Form CSRS-668, "Project Summary," of successful proposals will be published by USDA and, therefore, should not contain proprietary information.

(C) **Technical Content** - Begin the main body of the proposal on page 3 and include:

- (1) **Identification and Significance of the Problem or Opportunity** - Clearly state the specific technical problem or opportunity addressed and its importance.
- (2) **Background and Rationale** - Indicate the overall background and technical approach to the problem or opportunity and the part that the proposed research plays in providing needed results.
- (3) **Relationship with Future Research or Research and Development** - Discuss the significance of the phase I effort in providing a foundation for the phase II R&D effort. State the anticipated results of the approach if the project is successful (phases I and II). This should address: (a) the technical, economic, social, and other benefits to the Nation and to users of the results such as the commercial sector, the Federal Government, or other researchers; (b) the estimated total cost of the approach relative to benefits; and, if appropriate, (c) any specific policy issues or decisions which might be affected by the results.
- (4) **Phase I Technical Objectives** - State the specific objectives of the research or research and development effort, including the technical questions it will try to answer to determine the feasibility of the proposed approach.
- (5) **Phase I Work Plan** - This work plan must provide an explicit, detailed description of the research or research and development approach. The plan should indicate the tasks to be performed as well as how and where the work will be carried out. The phase I effort should attempt to determine the technical feasibility of the proposed concept. The work plan should be linked with the technical objectives of the research and the questions the effort is designed to answer. Therefore, it should flow logically from 3.3(C)(4) above. **This section should constitute a substantial portion of the total proposal.**

(6) **Related Research or Research and Development** - Describe significant research or R&D activities from relevant literature that are directly related to the proposed effort, including any conducted by the principal investigator or by the proposing small business, how it relates to the proposed effort, and any planned coordination with outside sources. **The proposer must persuade reviewers that he or she is aware of related research in the selected subject.**

(D) **Key Personnel and Bibliography** - Identify key personnel involved in the effort, including information on their directly related education and experience. For each key person, provide a chronological list of the most recent representative publications in the topic area during the preceding 5 years, including those in press. List the authors (in the same order as they appear on the paper), the full title, and the complete reference as these usually appear in journals. Where vitae are extensive, summaries that focus on the most relevant experience or publications may be necessary to meet the proposal size limitation in phase I and phase II.

(E) **Facilities and Equipment** - Describe the types, location, and availability of instrumentation and physical facilities necessary to carry out the work proposed. Items of equipment to be purchased must be fully justified under this section. When purchasing equipment or a product under the SBIR funding agreement, the small business should purchase only American-made items whenever possible. **If university facilities are being used, there must be a letter in the proposal from the authorized organizational representative of the university describing the arrangement and testifying that the facilities will be subject to the exclusive use and control of the applicant.**

(F) **Consultants** - Involvement of university or other consultants in the planning and research stages of the project is permitted and may be particularly helpful to small firms that have not previously received Federal research awards. If such involvement is intended, it should be described in detail. **Proposals must include letters from proposed consultants indicating willingness to serve in order for such participation to be considered during the proposal review and evaluation process (see subsection 4.3(D) or 4.4(E), as appropriate).**

(G) **Potential Post Application** - Briefly describe the commercialization potential of the proposed research. In addition, indicate whether there appears to be a potential use of the proposed research by the Federal Government. Include a brief description of the proposing company (e.g. date founded, number of employees) and its field of interest. What are the major competitive products in this field, and what advantages will the proposed research have over existing technology (in application, performance, technique, efficiency or cost).

(H) **Current and Pending Support** - If a proposal, substantially the same as the one submitted in response to this solicitation, has been previously funded or is currently funded, pending, or about to be submitted to another Federal agency or to USDA in a separate action, the proposer must provide the following information:

- (1) **Name and address of the agency(s) to which a proposal was submitted, or will be submitted, or from which an award is expected or has been received.**
- (2) **Date of actual or anticipated proposal submission or date of award, as appropriate.**
- (3) **Title of proposal or award, identifying number assigned by the agency involved, and the date of program solicitation under which the proposal was submitted or the award was received.**
- (4) **Applicable research topic area for each proposal submitted or award received.**
- (5) **Title of research project.**
- (6) **Name and title of principal investigator for each proposal submitted or award received.**

USDA will not make awards that duplicate research funded (or to be funded) by other Federal agencies.

(I) **Cost Breakdown on Proposal Budget** - Photocopy and complete Form CSRS-55 (9.3) only for the phase under which you are currently applying. (An applicant for phase I funding should not submit both phase I and phase II budgets.) Please note the following in completing the budget:

- (1) **Salaries and Wages** - Indicate the number and kind of personnel for whom salary support is sought. For key personnel, also indicate the number of work months of involvement to be supported with USDA funds (see section labeled "CSREES Funded Work Months"), and explain how the level of compensation was established, e.g., the hourly rate of pay, the monthly rate of pay, or the yearly rate of pay.
 - (2) **Equipment and Travel** - Performing organizations are expected to have appropriate facilities, suitably furnished and equipped. However, items of equipment may be requested provided that they are specifically identified and adequately justified (see item (E) of this section), **but such requests should normally not exceed 10% of the budget for phase I.** Equipment is defined as an article of nonexpendable, tangible personal property having a useful life of more than 2 years and an acquisition cost of \$500 or more per unit. **Vesting** of title to equipment purchased with funds provided under an SBIR funding agreement will be **determined by USDA.** **Awardees should plan to lease expensive equipment. Foreign travel may not be included in the phase I budget** but may be included as necessary in phase II proposals. The inclusion of either equipment or foreign travel will be carefully reviewed with respect to need and appropriateness for the research proposed.
 - (3) **Subcontracting Limits** - Subcontracting as defined in the program solicitation may not exceed one-third of the research or analytical effort during phase I and one-half of the research or analytical effort during phase II. In addition, **subcontractors must perform their portion of the work in the United States.** If subcontracting costs are anticipated, they should be indicated in block I., "All Other Direct Costs," on the budget sheet. A breakdown of subcontractual costs is required. **Note: For proposals involving subcontractual arrangements, the applicant must submit an agreement or letter of consent signed by the subcontractor in order for such participation to be evaluated during the proposal review process** (see subsection 4.3(D) or 4.4(E), as appropriate).
 - (4) **Fee** - A reasonable fee, not to exceed 7%, is permitted under this program solicitation but proposers are encouraged to minimize fee requests due to the small amount of funds available. **All fees are subject to negotiation with USDA.** If a fee is requested, the amount should be indicated in block M., "Other," on the budget sheet.
 - (5) **Indirect Costs** - If available, the current rate negotiated with the cognizant Federal negotiating agency should be used, unless restricted by statute. Indirect costs may not exceed the lesser of the negotiated rate or the rate restricted by statute. In Fiscal Year 1995 the rate, as restricted by statute, could not exceed 14% per centum of total Federal funds provided under each award. If no rate has been negotiated, a reasonable dollar amount in lieu of indirect costs may be requested, which will be subject to approval by USDA. A proposer may elect not to charge indirect costs and, instead, use all grant funds for direct costs. If a negotiated rate is used, the percentage and base should be indicated in the space allotted under item K. on the budget sheet. If indirect costs are not charged, the phrase "None requested" should be written in this space.
- (J) **Documentation of Multiple Phase II Awards**
- (1) A small business concern that submits a proposal for a funding agreement for Phase I of an SBIR Program and that has received more than 15 Phase II SBIR awards during the preceding 5 fiscal years must document the extent to which it was able to secure third phase funding to develop concepts resulting from previous second phase SBIR awards. In addition, the documentation must include the name of the awarding agency, date of award, funding agreement number, amount, topic or subtopic title, follow-on agreement amount, source and date of commitment and current commercialization status for each Phase II. (This information will not be counted toward the 25-page limitation.); and
 - (2) USDA shall collect and retain the information submitted under subparagraph J. (1) at least until the General Accounting Office submits the report required under section

(K) Certifications Regarding Non-Delinquency on any Federal Debt, Drug-free Workplace, Debarment and Suspension, and Lobbying - Certifications are accomplished by signing Form CSRS-667, Proposal Cover Sheet. (For instructions see subsection 5.15(G-J).)

(L) Assurance Statement(s) - Photocopy and complete Form CSRS-662 (9.4) and use it as the last page of the proposal. The original of the assurance statement(s) must at a minimum contain the pen-and-ink signature of the authorized organizational official. This form will not be considered a part of the 25-page limitation for Phase I proposals or the 50-page limitation for Phase II proposals.

(M) Organizational Management Information - Before the award of an SBIR funding agreement, USDA requires the submission of certain organizational management and financial information to assure the responsibility of the proposer. This information is not required unless a project is recommended for funding and is normally to be submitted on a one-time basis only, unless sufficient changes occur within the organization to warrant submission of new or additional information. **Phase II awardees will be asked to submit an updated statement of financial condition (such as the latest audit report, financial statement, or balance sheet).** The phase I applicant will be provided with the necessary details and forms to submit after being notified that the project has been recommended for funding. (See subsection 5.15(B) for more detailed information).

4.0 METHOD OF SELECTION AND EVALUATION CRITERIA

4.1 Introduction

Phase I and phase II proposals will be judged competitively in a two-stage process, based primarily upon scientific or technical merit. First, each proposal will be screened by USDA scientists to ensure that it is responsive to stated requirements contained in this solicitation (see subsection 4.2). Proposals found to be responsive will be technically evaluated by peer scientists knowledgeable in the appropriate scientific field using the criteria listed in subsection 4.3 or subsection 4.4, as appropriate. Each proposal will be judged on its own merits. **Unsolicited proposals or proposals not responding to research topic areas outlined in section 8.0 of this program solicitation are not eligible to be considered for a phase I SBIR award and, hence, will be returned to the proposing firm without review.**

External peer reviewers will be used during the technical evaluation stage of this process. Selections will be made from among recognized specialists who are uniquely qualified by training and experience in their respective fields to render expert advice on the merit of proposals received. It is anticipated that these experts will be drawn from universities, Government, and non-profit research organizations. If possible, USDA intends that peer review groups shall be balanced with minority and female representation and with an equitable age distribution.

Final decisions will be made by USDA based upon the ratings assigned by reviewers and consideration of other factors, **including the potential commercial applica-**

tion, possible duplication of other research, any critical USDA requirements, program balance, budget limitations and, for phase II proposals only, any follow-on funding commitment. There is no commitment by USDA to fund any particular proposal, to support any specific number of proposals in a given research topic area, or to make a specific number of awards under either phase I or phase II. USDA also may elect to fund several or none of the proposed approaches to the same topic. Care will be taken to avoid actual and potential conflicts of interest among reviewers. Evaluations will be confidential to USDA staff members, peer reviewers, and the proposed principal investigator(s), to the extent permitted by law.

4.2 Initial Screening Criteria

To avoid misunderstanding, applicants should be aware that **proposals not satisfying all of the screening criteria may be returned to the proposing entity without review. Returned proposals may not be resubmitted (with or without revision) under this solicitation.** The initial screening criteria are the following:

- (A) The proposing firm must qualify as a small business as defined in subsection 2.2.
- (B) The phase I proposal, including cover page, budget page, and proposal related attachments, **may not exceed 25 pages in length. Phase I proposals exceeding this 25-page limit will be returned without review.** The phase II proposal should not exceed 50 pages in length, including

cover page, budget, and all proposal-related enclosures or attachments. Typing for both phase I and phase II proposals must be on one side of the page only using standard size (8 1/2" x 11"; 21.6 cm x 27.9 cm) white paper, with no type smaller than 11 point font size regardless of whether it is single or double spaced.

- (C) Phase I proposals must be limited to one topic; however, a small business is free to submit several different proposals, each covering different approaches or topics. **Duplicate proposals will be returned without review.**
- (D) Phase I proposal budgets, including subcontracts, consultant charges, indirect costs, and fees, should not exceed \$55,000. Phase II budgets, including all proposed costs, should not exceed \$250,000.
- (E) The proposed duration of phase I projects should normally not exceed 6 months, except in special, justified circumstances, and the duration of phase II projects should normally not exceed 24 months. Where a proposed research project requires more than 6 months to complete in phase I, a longer grant period may be considered. A proposer of a phase I project with an anticipated duration beyond 6 months should specify and justify the length of duration in the proposal at the time of its submission to USDA in order for it to be considered.
- (F) The principal investigator's primary employment, that is, more than **one-half time**, must be with the small business concern at the time of award and during the conduct of the research. Primary employment with the applicant small business firm precludes full-time employment with another organization. (See subsection 2.2(C).) In addition, the work must be performed in the United States (see subsection 1.4).
- (G) A minimum of two-thirds of the research and/or analytical effort under each phase I proposal must be carried out by the proposing firm, while a minimum of one-half of the research and/or analytical effort must be carried out by the proposing firm under phase II.
- (H) **Foreign travel may not be included in phase I budgets** but may be included as necessary in phase II budgets.
- (I) Proposals must cover scientific research activities only (see subsection 3.1).

(J) The proposed phase I research must fall within a solicited topic area. (See section 8.0 for the listing of research topic descriptions.)

(K) A proposal must contain adequate scientific/technical information to state clearly the research plan and objectives. **USDA reserves the right not to submit for review any proposal which it finds to have insufficient information.**

4.3 Phase I Evaluation Criteria

USDA plans to select for award those proposals offering the best value to the Nation with approximately equal consideration given to each of the following criteria, **except for item (A) which will receive twice the value of any of the other items:**

- (A) **The scientific/technical** quality of the phase I research plan and its relevance to the stated objectives, with special emphasis on innovativeness and originality.
- (B) **Importance of the problem or opportunity and anticipated commercial potential** of the proposed research, if successful.
- (C) **Adequacy of the phase I objectives** to show incremental progress toward proving the feasibility of approach.
- (D) **Qualifications of the principal investigator(s)**, other key staff and consultants, and the probable adequacy of available or obtainable instrumentation and facilities.

4.4 Phase II Evaluation Criteria

A phase II proposal may be submitted **only** by a USDA phase I awardee. The phase II proposal will be reviewed for overall merit based on the following criteria with each item receiving approximately equal weight, **except for items (A) and (B) which will receive twice the value of any of the other items:**

- (A) The scientific/technical quality of the proposed research, with special emphasis on innovativeness and originality.
- (B) Degree to which phase I objectives were met and feasibility was established.
- (C) The technical, economic, and/or social importance of the problem or opportunity and anticipated commercial potential if phase II research is successful.

- (D) The adequacy of the phase II objectives to meet the problem or opportunity.
- (E) The qualifications of the principal investigator(s) and other key personnel to carry out the proposed work.
- (F) Reasonableness of the budget requested for the work proposed.

In the event that two or more proposals are of approximately equal technical merit, a follow-on funding commitment for continued development in phase III will be an important consideration. The value of any commitment will depend upon the degree of commitment made by non-Federal investors, with the **maximum value resulting from a signed agreement with reasonable terms for an amount at least equal to the funding requested from USDA in phase II.**

4.5 Notice to Proposers

Technical reviewers will base their conclusions and recommendations on information contained in the phase I or phase II proposal. It cannot be assumed that reviewers are acquainted with any experiments referred to within a proposal, with key individuals, or with the small business itself.

After final decisions have been announced, written reviews of the proposal will be sent to the proposed principal investigator(s) involved, but the reviews will not include the identities of the reviewers, in accordance with the SBIR Policy Directive. Due to funding limitations and USDA's desire to support as many worthwhile projects as possible, it may be necessary for USDA to reduce the amount of an award below the amount requested by a small business (or to fund only certain objectives outlined in the proposal). Any significant changes will be discussed with the proposing firm, which may then be asked to submit a revised budget reflecting the reduced amount. In the event that this occurs, specific instructions will be provided to the proposer.

5.0 CONSIDERATIONS

5.1 Awards

USDA expects to make approximately 60 phase I awards ranging up to \$55,000 each to small businesses in fiscal year 1996, depending upon the availability of funds. Awards are expected to be made on or before May 15, 1996. USDA will announce the names of those concerns receiving awards, and successful proposers will then normally have 6 months after awards are made to carry out their proposed phase I effort.

USDA expects to make approximately 28 phase II awards ranging up to \$250,000 each to previous USDA phase I awardees, depending upon the results of the phase I efforts and the availability of funds.

In accordance with the guidelines contained in 31 U.S.C. 6301-6308, and the authority contained in Section 630 of the Act making appropriations for Agriculture, Rural Development, and Related Agencies' programs for fiscal year ending September 30, 1987, and for other purposes, as made applicable by Section 101(a) of Public Law Number 99-591, 100 Stat. 3341, **all phase I and phase II awards will be issued as research grants.** A fee (i.e., estimated profit) for the proposing firm, not to exceed 7%, will be permitted under both phases of this program, subject to negotiation with USDA.

5.2 Reports

An original and two copies of a comprehensive final performance report on the phase I SBIR project must be submitted within 30 days following expiration of the grant. The report should include a single-page project summary as the first page. This summary should include the purpose of the research, a brief description of the research carried out, the research findings or results, and, in a final paragraph, potential applications (commercial or other) of the research. The balance of the report should include a comparison of actual accomplishments with the goals established for the grant; the reasons for slippage if established goals were not met; estimates of technical feasibility; and additional pertinent information such as an explanation of cost over-runs or unexpectedly high unit costs. In addition, identify all other recipients (public and private) of the research results documented in the phase I report. This report should be submitted to:

Dr. Charles F. Cleland
 Director, SBIR Program
 Cooperative State Research, Education, and
 Extension Service
 U.S. Department of Agriculture
 Ag Box 2243
 Washington, D.C. 20250-2243
 Telephone: (202) 401-4002

A final "Financial Status Report" (SF-269) is due within 90 days after the expiration date of the grant and should be submitted to the Cooperative Funds Division at the address listed below, in accordance with instructions contained in Section 3015.82 of the Uniform Federal Assistance Regulations.

Mr. Philip A. Carter
Director, Cooperative Funds Division
Cooperative Management Staff
Cooperative State Research, Education, and
Extension Service
U.S. Department of Agriculture
Ag Box 0995
Washington, D.C. 20250-0995
Telephone: (202) 401-6309

5.3 Payment Schedules

Payments will be made to the recipient either by advance or reimbursement by Treasury Check. The specific method and frequency of payment, as well as required forms and pertinent submission instructions for each project, will be provided to the small business concern when the funding agreement is forwarded to it for acceptance.

5.4 Proprietary Information

If a proposal contains proprietary information that constitutes a trade secret, proprietary commercial or financial information, confidential personal information, or data affecting the national security, it will be treated in confidence to the extent permitted by law, provided the information is clearly marked by the proposer with the term "confidential proprietary information," is confined to a separate page or pages, and provided the following legend also appears in the designated area at the bottom of the proposal's cover sheet (Form CSRS-667):

The following pages (specify) contain proprietary information which (name of proposing organization) requests not be released to persons outside the Government, except for purposes of evaluation.

USDA, by law, is required to make the final decision as to whether the information is required to be kept in confidence. Information contained in unsuccessful proposals will remain the property of the proposer. However, USDA will retain for 1 year one file copy of all proposals received; extra copies will be destroyed. Public release of information for any proposal submitted will be subject to existing statutory and regulatory requirements. The legislation reauthorizing the SBIR Program strengthened the protection of awardee firms relative to

maintaining confidentiality of proprietary information for a period of 4 years after the end of the grant period. However, any proposal which is funded will be considered an integral part of the award and normally will be made available to the public upon request through the Freedom of Information Act, except for designated proprietary information.

The inclusion of proprietary information is discouraged unless it is necessary for the proper evaluation of the proposal. If proprietary information is to be included, it should be limited, set apart from other text on a separate page, and keyed to the text by numbers. It should be confined to a few critical technical items which, if disclosed, could jeopardize the obtaining of foreign or domestic patents. Trade secrets, salaries, or other information which could jeopardize commercial competitiveness should be similarly keyed and presented on a separate page. Proposals or reports which attempt to restrict dissemination of large amounts of information may be found unacceptable by USDA. **Any other legend than that listed in the second paragraph of this section may be unacceptable to USDA and may constitute grounds for return of the proposal without further consideration.** Without assuming any liability for inadvertent disclosure, USDA will limit dissemination of such information to its employees and, where necessary for the evaluation of the proposal, to outside reviewers on a confidential basis. Since technical reports by the principal investigator(s) may be made available to the public, such reports shall not contain any restrictive language purporting to limit their use other than that which is set off on a proprietary page. However, USDA, to the extent permitted by law, normally will honor a request to delay release of the report for 6 months, or longer if reasonable, so the proposer may seek patent protection or follow-on-funding where appropriate.

5.5 Rights in Technical Data

Rights in technical data, including software developed under the terms of any funding agreement resulting from a proposal submitted in response to this solicitation, shall remain with the grantee. However, the Government shall have the limited right to use such data for Governmental purposes and shall not release such data outside the Government without permission of the grantee for a period of 4 years from completion of the project under which the data were generated. Effective at the conclusion of the 4-year period, the Government shall retain a royalty-free license for Governmental use of any technical data delivered under the agreement, whether patented or not.

5.6 Copyrights

With prior written permission of the Authorized Departmental Officer, the grantee normally may copyright and publish (consistent with appropriate national security considerations, if any) material developed with USDA support. USDA receives a royalty-free license for the Federal Government and requires that each publication contain the following acknowledgment and disclaimer statement:

“This material is based upon work supported by the U.S. Department of Agriculture under Grant No. (awardee should enter agreement number here). Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the U.S. Department of Agriculture.”

The last sentence may be omitted from articles published in scientific journals.

5.7 Patents and Inventions

Allocation of rights to inventions shall be in accordance with 35 U.S.C. 202-206 and the final rule published in the Federal Register (52 FR 8552-8563) by the Department of Commerce entitled “Rights to Inventions Made by Nonprofit Organizations and Small Business Firms” (37 CFR Part 401). These regulations provide that small businesses normally may retain the principal worldwide patent rights to any invention developed with USDA support. USDA receives a royalty-free license for Federal Government use, reserves the right to require the patentee to license others in certain circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must normally manufacture it domestically. To the extent authorized by 35 U.S.C. 205, USDA will not make public any information disclosing a USDA-supported invention for a 4-year period to allow the grantee a reasonable time to file an initial patent application. Additional information may be obtained by contacting:

Mr. M. Howard Silverstein
Deputy Assistant General Counsel for Patents
U.S. Department of Agriculture
Ag Box 1401
Washington, D.C. 20250-1401

5.8 American-made Equipment and Products

In the Small Business Research and Development Enhancement Act of 1992, Congress expressed the desire that an entity that is awarded a funding agreement under the SBIR Program of a Federal agency under section 9 of

the Small Business Act should, when purchasing any equipment or a product with funds provided through the funding agreement, purchase only American-made equipment and products, to the extent possible in keeping with the overall purposes of the program.

5.9 Cost Sharing

Cost sharing is permitted for proposals under this program solicitation; however, cost sharing is not required nor will it be an evaluation factor in considering the competitive merit of proposals submitted.

5.10 Profit or Fee

Fees, not to exceed 7%, will be allowed under both phase I and phase II awards. However, because of the limited amount of funds available, proposers are encouraged to keep such fees to a minimum. Fees are subject to negotiation with USDA.

5.11 Joint Ventures and Limited Partnerships

Joint ventures and limited partnerships are eligible to apply for and to receive research grants under this program solicitation, **provided that the entity created qualifies as a small business as defined in subsection 2.2. A joint venture must provide documentation confirming that it can act as a single legal entity for purposes of a grant awarded under the SBIR program.**

5.12 Research and Analytical Work

- (A) For phase I a minimum of two-thirds of the research and/or analytical effort must be performed by the proposing firm.
- (B) For phase II a minimum of one-half of the research and/or analytical effort must be performed by the proposing firm.

5.13 Research Involving Special Considerations

A number of situations frequently encountered in the conduct of scientific research require the submission of special information for a particular project. Since some types of research targeted for SBIR support have high probability of involving either recombinant deoxyribonucleic acid (DNA) molecules, human subjects at risk, or vertebrate animals, special instructions follow.

If the proposed research will involve either recombinant DNA molecules, human subjects at risk, or vertebrate animals, the proposal must so indicate by checking “Yes” in Item 9 of Form CSRS-667 and then completing Form

CSRS-662. Further, in the event that the project is funded, the proposer may be required to have the research plan reviewed and approved by an appropriate "Institutional Review Board" prior to commencing actual substantive work. It is suggested that proposers contact local universities, colleges, or nonprofit research organizations which have established such reviewing mechanisms to have this service performed.

Guidelines to be applied and observed when conducting such research are outlined below.

(A) **Recombinant DNA Molecules** - Principal investigators and authorized organizational officials must comply with the "Guidelines for Research Involving Recombinant DNA Molecules" issued by the National Institutes of Health, 51 FR 16958-16985, as revised.

(B) **Human Subjects at Risk** - Regulations issued by the Department of Agriculture to be used in safeguarding the rights and welfare of human subjects used in research supported with USDA grant funds are contained in 7 CFR part 1c.101, *et. seq.* (See 56 FR 28012.)

(C) **Animal Care** - Principal investigators and authorized organizational officials must comply with regulations issued by the Department of Agriculture, 9 CFR parts 1, 2, 3, and 4.

5.14 Grantee Commitments

Upon issuance of a research grant by USDA, the awardee will be required to make certain legal commitments through acceptance of the award document and the terms and conditions attached thereto, as well as any project-specific terms or conditions outlined. Most of these terms and conditions are contained in USDA's Uniform Federal Assistance Regulations, 7 CFR Part 3015, which will be incorporated into all awards resulting from this program solicitation and will be mailed in the package of materials when the research grant is forwarded to the awardee for acceptance. These regulations primarily consolidate internal policies and procedures relating to USDA's assistance programs and implement various Federally issued assistance policies, including applicable Federal cost principles and uniform administrative requirements. Advance copies of these regulations are available upon request.

The following clauses illustrate the types of terms and conditions a small business concern will be asked to accept if awarded a research grant under this program. This is not a complete listing nor the exact wording of the clauses as they will appear in the funding agreement.

(A) **Standards of Work** - Work performed under the grant must conform to high professional standards. Responsibility for performance of the principal investigator(s) and other employees or consultants who carry out the work lies with the management of the organization receiving the award.

(B) **Inspection** - Work performed under the grant is subject to Government inspection and evaluation at all times.

(C) **Examination of Records** - The Comptroller General (or a duly authorized representative) shall have the right to examine any directly pertinent records of the grantee involving transactions related to the funding agreement.

(D) **Termination for Cause** - USDA may terminate the funding agreement in whole, or in part, if the grantee materially fails to perform the work for which the funding agreement is issued or otherwise fails to comply with the terms of the grant.

(E) **Termination by Mutual Agreement** - The grant may be terminated in whole, or in part, when both parties agree that the continuation of the project would not produce beneficial results commensurate with the further expenditure of funds.

(F) **Equal Opportunity** - The grantee shall not discriminate against any employee or applicant for employment because of race, color, religion, age, sex, national origin, physical or mental handicap, or status as a veteran of the Vietnam era.

5.15 Additional Information

(A) This program solicitation is intended for informational purposes and reflects current planning. If there is any inconsistency between the information contained herein and the terms of any resulting SBIR funding agreement, the terms of the funding agreement are controlling.

(B) Before the award of an SBIR funding agreement, USDA requires the submission of certain organizational management, personnel, and financial information to assure responsibility of the proposer, including certification that the proposing organization is in compliance with the Civil Rights Act of 1964. Form CSRS-666 (both sides) should be completed to provide the necessary organizational information, and Form CSRS-665 should be used to certify compliance with

Title VI of the Civil Rights Act of 1964. (If portions of the information requested on Form CSRS-666 are not applicable to the proposing organization or entity, "N/A" should be written in the space provided.) **These forms will be provided to the small business concern by the Awards Management Division (AMD), CSREES, prior to the forwarding of the funding agreement for acceptance.** The information contained in both forms must normally be submitted **on a one-time basis only.** (If sufficient changes occur within the organization to warrant submission of new or additional information, additional forms should be requested from AMD by calling (202) 401-5050.) It is anticipated that all phase I awardees will be required to submit the above information, but phase II awardees will be concerned primarily with submitting new forms **only** if they have undergone significant changes in organization, personnel, finance, or policies including those relating to civil rights. **Phase II awardees will be asked to submit an updated statement of financial condition (such as the latest audit report, financial statement or balance sheet).**

- (C) USDA is not responsible for any monies expended by the proposer prior to the award of any funding agreement.
- (D) This program solicitation is not an offer by USDA and does not obligate USDA to make any specific number of awards. Also, awards under this program are contingent upon the availability of funds.
- (E) **Unsolicited proposals will not be accepted** under the SBIR program in either phase I or phase II.
- (F) If an award is made under this program solicitation, the grantee will be required to certify that it has not previously been, nor is currently being, paid for essentially equivalent work by **any agency** of the Federal Government.
- (G) **Instructions for Statement as to Delinquency on Federal Debts by Applicants for Federal Assistance** - Pursuant to OMB Circular A-129, (implemented by USDA in 7 CFR Part 3), "Except where required by law or approved by the head of the agency, no award of Federal funds shall be made to an applicant who is delinquent on a Federal debt until the delinquent account is made current or satisfactory arrangements are made between affected agencies and the debtor."

The certification of non-delinquency applies only to the organization requesting financial assistance and not to the individual Principal Investigator. By signing Form CSRS-667, Proposal Cover Sheet, the applicant is providing the statement of non-delinquency on any Federal debt. For the purposes of this statement, the following definitions of delinquency apply:

- (1) Direct loans - a debt more than 31 days past due on a scheduled payment.
- (2) Grants - recipients of a "Notice of Grants Cost Disallowance" who have not repaid the disallowed amount or who have not resolved the disallowance.
- (3) Guaranteed and insured loans - recipients of a loan guaranteed by the Federal Government that the Federal Government has repurchased from a lender because the borrower breached the loan agreement and is in default.

Examples of debts include delinquent taxes, audit disallowances, guaranteed and direct student loans, housing loans, farm loans, business loans, Department of Education institutional loans, benefit overpayments and other miscellaneous administrative debts.

NOTE: An applicant answering "Yes" to this question must attach explanatory information detailing all relevant particulars concerning the Federal debt.

- (H) **Certifications Regarding Drug-Free Workplace Requirements (Grants) - Alternative I - For Grantees Other Than Individuals, and Alternative II - For Grantees Who are Individuals** - These certifications are required by the regulations implementing Sections 5151-5160 of the Drug-Free Workplace Act of 1988 (Pub. L. 100-690, Title V, Subtitle D; 41 U.S.C. 701 et seq.), 7 CFR Part 3017, Subpart F, Section 3017.600, Purpose. The January 31, 1989, regulations were amended and published as Part II of the May 25, 1990, **Federal Register** (pages 21681-21691). Copies of the regulations may be obtained by contacting CSREES.

Certification Regarding Drug-Free Workplace Requirements, Alternative I, For Grantees Other Than Individuals

The grantee certifies that it will or will continue to provide a drug-free workplace by:

- (a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;
- (b) Establishing an ongoing drug-free awareness program to inform employees about —
 - (1) The dangers of drug abuse in the workplace;
 - (2) The grantee's policy of maintaining a drug-free workplace;
 - (3) Any available drug counseling, rehabilitation, and employee assistance programs; and
 - (4) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace;
- (c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);
- (d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will —
 - (1) Abide by the terms of the statement; and
 - (2) Notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace no later than five calendar days after such conviction;
- (e) Notifying the agency in writing, within ten calendar days after receiving notice under subparagraph (d)(2) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to every grant officer on whose grant activity the convicted employee was working, unless the Federal agency has designated a central point for the receipt of such notices. Notice shall include the identification number(s) of each affected grant;
- (f) Taking one of the following actions, within 30 calendar days of receiving notice under subparagraph (d)(2), with respect to any employee who is so convicted —
 - (1) Taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of the Rehabilitation Act of 1973, as amended; or
 - (2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency;
- (g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (a), (b), (c), (d), (e) and (f).

Certification Regarding Drug-Free Workplace Requirements, Alternative II, For Grantees Who Are Individuals

- (a) The grantee certifies that, as a condition of the grant, he or she will not engage in the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance in conducting any activity with the grant.
- (b) If convicted of a criminal drug offense resulting from a violation occurring during the conduct of any grant activity, he or she will report the conviction, in writing, within 10 calendar days of the conviction, to the grant officer or other designee, unless the Federal agency designates a central point for the receipt of such notices. When notice is made to such a central point, it shall include the identification number(s) of each affected grant.

Instructions for Certification of Drug-Free Workplace Requirements

1. By signing Form CSRS-667, the grantee is providing the certification set forth above.
2. The certification is a material representation of fact upon which reliance is placed when the agency awards the grant. If it is later determined that the grantee knowingly rendered a false certification, or otherwise violates the requirements of the Drug-Free Workplace

Act, the agency, in addition to any other remedies available to the Federal Government, may take action authorized under the Drug-Free Workplace Act.

3. Workplaces under grants, for grantees other than individuals, need not be identified on the certification. If known, they may be identified in the grant application. If the grantee does not identify the workplaces at the time of application, or upon award, if there is no application, the grantee must keep the identity of the workplace(s) on file in its office and make the information available for Federal inspection. Failure to identify all known workplaces constitutes a violation of the grantee's drug-free workplace requirements.

4. Workplace identifications must include the actual address of buildings (or parts of buildings) or other sites where work under the grant takes place. Categorical descriptions may be used (e.g., all vehicles of a mass transit authority or State highway department while in operation, State employees in each local unemployment office, performers in concert halls or radio studios).

5. If the workplace identified to the agency changes during the performance of the grant, the grantee shall inform the agency of the change(s), if it previously identified the workplaces in question (see paragraph three).

6. Definitions of terms in the Nonprocurement Suspension and Debarment common rule and Drug-Free Workplace common rule apply to this certification. Grantees' attention is called, in particular, to the following definitions from these rules:

"Controlled" substance means a controlled substance in Schedules I through V of the Controlled Substances Act (21 U.S.C. 812) and as further defined by regulation (21 CFR 1308.11 through 1308.15);

"Conviction" means a finding of guilt (including a plea of nolo contendere) or imposition of sentence, or both, by any judicial body charged with the responsibility to determine violations of the Federal or State criminal drug statutes;

"Criminal drug statute" means a Federal or non-Federal criminal statute involving the manufacture, distribution, dispensing, use, or possession of any controlled substance;

"Employee" means the employee of a grantee directly engaged in the performance of work under a grant, including: (i) all "direct charge" employees; (ii) all "indirect charge" employees unless their impact or involvement is insignificant to the performance of the grant; and,

(iii) temporary personnel and consultants who are directly engaged in the performance of work under the grant and who are on the grantee's payroll. This definition does not include workers not on the payroll of the grantee (e.g., volunteers, even if used to meet a matching requirement; consultants or independent contractors not on the grantee's payroll; or employees of subrecipients or subcontractors in covered workplaces).

(I) Debarment or Suspension Requirements - Certification Regarding Debarment, Suspension, and Other Responsibility Matters - Primary Covered Transactions, and Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions (Form AD-1048).

These certifications are required by the regulations implementing Executive Order 12549, Debarment and Suspension, 7 CFR Part 3017, Section 3017.510, Participants' responsibilities. The regulations were published as Part IV of the January 30, 1989, **Federal Register** (pages 4722-4733). Copies of the regulation may be obtained by contacting CSREES.

Form AD-1048 containing certification for each lower tiered covered transaction will be sent to each Phase I and Phase II grantee at the time of award with the award letter. It should not be submitted to CSREES but should be maintained by the applicant with the other records relating to the proposed project.

Certification For Primary Covered Transactions

- (1) The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:
 - (a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;
 - (b) have not within a 3-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing

a public (Federal, State or Local) transaction or contract under a public transaction; violation of Federal or State anti-trust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

- (c) are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or Local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and
 - (d) have not within a 3-year period preceding this application/proposal had one or more public transactions (Federal, State or Local) terminated for cause or default.
- (2) Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

Instructions on Certification Regarding Debarment And Suspension

1. By signing Form CSRS-667, the prospective primary participant is providing the certification for primary covered transactions set forth above.

2. The inability of a person to provide the certification will not necessarily result in denial of participation in this covered transaction. The prospective participant shall submit an explanation of why it cannot provide the certification. The certification or explanation will be considered in connection with the department or agency's determination whether to enter into this transaction. However, failure of the prospective primary participant to furnish a certification or an explanation shall disqualify such person from participation in this transaction.

3. The certification in this clause is a material representation of fact upon which reliance was placed when the department or agency determined to enter into this transaction. If it is later determined that the prospective primary participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause or default.

4. The prospective primary participant shall provide immediate written notice to the Authorized Departmental Officer in accordance with 7 CFR Part 3017.510(c) if at any time the prospective primary participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

5. The terms "covered transaction," "debarred," "suspended," "ineligible," "lower tier covered transaction," "participant," "person," "primary covered transaction," "principal," "proposal," and "voluntarily excluded," as used in this clause, have the meaning set out in the Definitions and Coverage sections of the rules implementing Executive Order 12549. You may contact CSREES for assistance in obtaining a copy of those regulations.

6. The prospective primary participant agrees by certification that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency entering into this transaction.

7. The prospective primary participant further agrees by certification that it will include the clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions," from Form AD-1048, provided by the department or agency entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.

8. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant will require its prospective lower tier participants to provide immediately written notice to the proposer if at any time the prospective lower tier participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances. A participant may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the Nonprocurement List. As used herein, lower tier covered transactions generally include:

- a. Any transaction (other than a procurement contract) for goods and services, regardless of type;

- b. Any procurement contract for goods and services, regardless of type, that is expected to equal or exceed the Federal cap on small purchases (currently, \$25,000); and
- c. Any procurement contract for goods and services, regardless of amount, under which the recipient will have a critical influence on or substantive control over the covered transaction (i.e., principal investigators and providers of federally required audit services).

9. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of a participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

10. Except for transactions authorized under paragraph 6 of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause or default.

(J) Notice to Applicants - Certification/Disclosure Requirements Related to Lobbying - Section 319 of Public Law 101-121 (31 U.S.C.), signed into law on October 23, 1989, imposes new prohibitions and requirements for disclosure and certification related to lobbying on recipients of Federal contracts, grants, cooperative agreements, and loans. Certain provisions of the law also apply to Federal commitments for loan guarantees and insurance; however, it provides exemptions for Indian tribes and tribal organizations.

Effective December 23, 1989, current and prospective recipients (and their subtier contractors and/or subgrantees) will be prohibited from using Federal funds, other than profits from a Federal contract, for lobbying Congress or any Federal agency in connection with the award of a particular contract, grant, cooperative agreement or loan. In addition, for each award action in excess of \$100,000 (or \$150,000 for loans) on or after December 23, 1989, the law requires recipients and their subtier contractors and/or subgrantees to: (1) certify that they have neither used nor will use any appropriated funds for payment to lobbyists, (2) disclose the name, address, payment details, and purpose of any agreements with lobbyists whom recipients or their subtier contractors or

subgrantees will pay with profits or **nonappropriated** funds on or after December 23, 1989; and (3) file quarterly updates about the use of lobbyists if material changes occur in their use. The law establishes civil penalties for noncompliance.

If you are a current recipient of funding or have an application, proposal, or bid pending as of December 23, 1989, the law will have the following immediate consequences for you:

You are prohibited from using appropriated funds (other than profits from Federal contracts) on or after December 23, 1989, for lobbying Congress or any Federal agency in connection with a particular contract, grant, cooperative agreement, or loan;

you are required to execute the certification at the time of submission of an application or before any action in excess of \$100,000 is awarded; and

you will be required to complete the lobbying disclosure form, Standard Form-LLL, if the disclosure requirements apply to you. This form will be sent by the SBIR Program Director to all eligible Phase II applicants with the letter requesting Phase II proposals and it will also be sent by the Awards Management Division to all applicants requesting it.

Regulations implementing Section 319 of Public Law 101-121 have been published as an Interim Final Rule by the Office of Management and Budget as Part III of the February 26, 1990, **Federal Register** (pages 6736-6746).

Certification Regarding Lobbying - Contracts, Grants, Loans, and Cooperative Agreements - In signing Form CSRS-667, the applicant certifies, to the best of his or her knowledge and belief, that:

1. No Federal appropriated funds have been paid or will be paid, by or on behalf of the applicant, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal Loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan or cooperative agreement;

2. If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of

any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with a Federal contract, grant, loan, or cooperative agreement, the applicant shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions;

3. The applicant shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

(K) Compliance with the National Environmental Policy Act (NEPA) - As outlined in 7 CFR Part 3407 (the Cooperative State Research, Education, and Extension Service regulations implementing NEPA), the environmental data for any proposed project is to be provided to CSREES so that CSREES may determine whether any further action is needed. In some cases, however, the preparation of environmental data may not be required. Certain categories of actions are excluded from the requirements of NEPA. The applicant shall review the following categorical exclusions and determine if the proposed project may fall within one of the categories.

(1) Department of Agriculture Categorical Exclusions (7 CFR 1b.3).

- (i) Policy development, planning and implementation which relate to routine activities such as personnel, organizational changes, or similar administrative functions;
- (ii) Activities which deal solely with the funding of programs, such as program budget proposals, disbursements, and transfer or reprogramming of funds;
- (iii) Inventories, research activities, and studies, such as resource inventories and routine data collection when such actions are clearly limited in context and intensity;

- (iv) Educational and informational programs and activities;
- (v) Civil and criminal law enforcement and investigative activities;
- (vi) Activities which are advisory and consultative to other agencies and public and private entities; and
- (vii) Activities related to trade representation and market development activities abroad.

(2) CSREES Categorical Exclusions (7 CFR 3407.6). Based on previous experience, the following categories of CSREES actions are excluded because they have been found to have limited scope and intensity and to have no significant individual or cumulative impacts on the quality of the human environment:

- (i) The following categories of research programs or projects of limited size and magnitude or with only short-term effects on the environment:
 - (A) Research conducted within any laboratory, greenhouse, or other contained facility where research practices and safeguards prevent environmental impacts;
 - (B) Surveys, inventories, and similar studies that have limited context and minimal intensity in terms of changes in the environment; and
 - (C) Testing outside of the laboratory, such as in small isolated field plots, which involves the routine use of familiar chemicals or biological materials.
- (ii) Routine renovation, rehabilitation, or revitalization of physical facilities, including the acquisition and installation of equipment, where such activity is limited in scope and intensity.

In order for CSREES to determine whether any further action is needed with respect to NEPA, pertinent information regarding the possible environmental impacts of a particular project is necessary; therefore, Form CSRS-1234, "NEPA Exclusions Form," must be included in the proposal indicating whether the applicant is of the opinion that the project falls within a categorical exclusion and the reasons therefor. If it is the applicant's opinion that the proposed project falls within the categorical exclusions, the

specific exclusion must be identified. The information submitted shall be identified in the Table of Contents as NEPA Considerations and Form CSRS-1234 and supporting documentation shall be placed after the Form CSRS-667, "Proposal Cover Sheet," in the proposal. This form will not be considered as part of the 25-page limitation for phase I proposals or the 50-page limitation for phase II proposals.

Even though a project may fall within the categorical exclusions, CSREES may determine that an Environmental Assessment or an Environmental Impact Statement is necessary for an activity, if substantial controversy on environmental grounds exists or if other extraordinary conditions or circumstances are present which may cause such activity to have a significant environmental effect.

6.0 SUBMISSION OF PROPOSALS

6.1 Deadlines for Proposals

All phase I proposals must be postmarked or delivered to the address and room number shown in subsection 6.3 by **September 14, 1995**. Applicants hand-delivering proposals must secure a time-and-date-stamped receipt. Proposals not postmarked or delivered by this date will be returned to the proposing organization without evaluation or consideration for award.

All Phase II proposals must be postmarked or delivered to the address shown in the letter requesting phase II proposals by **February 15, 1996**. Proposals not postmarked or delivered by this date will be returned to the proposing organization without evaluation or consideration for award. Only those small businesses previously receiving phase I awards in either fiscal years 1994 or 1995 are eligible to submit phase II proposals in fiscal year 1996. The Director, SBIR Program will send a letter to all eligible phase I awardees requesting phase II proposals.

For the convenience of all potential proposers, the following schedule is provided for informational purposes:

Phase I

Proposal postmark or delivery receipt date	by September 14, 1995
Notification of proposals received	approximately October 15, 1995
Notification of recommended awards and declinations	approximately March 1, 1996
Period of research performance	May 15, 1996 - November 30, 1996
Final Report due at USDA	December 31, 1996

Phase II

Proposal postmark	by February 15, 1996
Notification of awards and declinations	approximately June 30, 1996
Beginning period of research performance	approximately September 1, 1996

6.2 Number of Copies

Proposers under both phase I and phase II are requested to submit an original and 14 copies of all proposals. These proposals must contain all of the information, arranged in the same order, as that outlined in section 3.0.

6.3 Address

All proposals, whether phase I or phase II, must be submitted to the office listed below.

Proposals submitted through the regular mail must be postmarked by September 14, 1995, for Phase I proposals and February 15, 1996, for Phase II proposals and should be sent to the following address:

Proposal Services Branch
Awards Management Division
Cooperative State Research, Education, and Extension Service
U.S. Department of Agriculture
Ag Box 2245
Washington, D.C. 20250-2245

NOTE: Hand-delivered proposals must be submitted to an express mail or a courier service, or brought to the following address by September 14, 1995, for Phase I proposals and February 15, 1996, for Phase II proposals: Proposal Services Branch; Awards Management Division; Cooperative State Research, Education, and Extension Service; U.S. Department of Agriculture; Room 303, Aerospace Center; 901 D Street,

S.W.; Washington, D.C. 20024. The telephone number is (202) 401-5048.

6.4 Acknowledgment of Proposals

All proposals will be acknowledged. The acknowledgment will be issued in the form of a letter and, at a minimum, will contain the title of the proposed project, proposal number assigned by USDA, and date of receipt. Later inquiries, submissions of addenda prior to the applicable deadline for proposals, and the like should include this information.

6.5 Bindings

Do not use special bindings or covers on proposals submitted in response to this program solicitation. Staple all pages together securely in the upper left-hand corner of each copy of each proposal.

6.6 Packaging

If possible, the original and all copies of each proposal should be mailed in one package. Due to the volume of proposals received, applications submitted in several packages are very difficult to identify and track. If it becomes necessary to mail copies of a proposal in more than one package, the number of packages should be marked on the outside of each. It is important that **all packages be mailed at the same time.**

6.7 Questions Pertaining to the USDA SBIR Program or to this Solicitation

Written or verbal questions of a general nature about the USDA SBIR program, as well as general questions per-

taining to this solicitation (but **not** pertaining to requests for additional copies of the solicitation), should be directed to:

Dr. Charles F. Cleland
Director, SBIR Program
Cooperative State Research, Education, and
Extension Service
U.S. Department of Agriculture
Ag Box 2243
Washington, D.C. 20250-2243
Telephone: (202) 401-4002

6.8 Requests for Additional Copies of this Solicitation

Additional copies of this solicitation may be ordered by writing to the address shown in subsection 6.3 or by calling (202) 401-5048.

6.9 Information on Proposal Status

It is anticipated that the evaluation of phase I proposals will require approximately 6 months from September 14, 1995, and no information on proposals status will be available until final selections have been made. Both successful and unsuccessful proposers will be notified of final award decisions within approximately 6 months.

Evaluation of **phase II** proposals will require approximately four months from February 15, 1996. Again, proposers are discouraged from making inquiries regarding the status of their proposals. All proposing organizations will be notified of final award decisions within approximately 4 months.

7.0 SCIENTIFIC AND TECHNICAL INFORMATION SOURCES

Listed below are some of the sources that can provide technology search and document services which may be useful in preparing SBIR proposals. They can be contacted directly for service and cost information.

National Agricultural Library
Reference Staff
U.S. Department of Agriculture
Beltsville, Maryland 20705
(301) 344-4479

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161
(703) 487-4600

Aerospace Research Applications Center
611 North Capitol Avenue
Indianapolis, Indiana 46204
(317) 262-5003

Rural Enterprises, Inc.
422 Cessna Street
Durant, Oklahoma 74701
(405) 924-5094

Southern Technology Applications Center
College of Engineering
University of Florida
One Progress Boulevard
Box 24
Alachua, Florida 32615
(904) 462-3913

Mid-Atlantic Technology Applications Center
University of Pittsburgh
823 William Pitt Union
Pittsburgh, Pennsylvania 15260
(412) 648-7000

Far West Technology Transfer Center
University of Southern California
3716 South Hope Street, Suite 200
Los Angeles, California 90007-4344
(213) 743-6132

Commercial Technology Services
Texas Engineering Experiment Station
The Texas A&M University System
237 Wisenbaker Engineering Research Center
College Station, Texas 77843-3401
(409) 845-8762

Great Lakes Industrial Technology Center
Battelle Memorial Institute
25000 Great Northern Corporate Center, Suite 450
Cleveland, Ohio 44070
(216) 734-0094

Center for Technology Commercialization
Massachusetts Technology Park
100 North Drive
Westborough, Massachusetts 01581
(508) 870-0042

National Technology Transfer Center
Wheeling Jesuit College
316 Washington Avenue
Wheeling, West Virginia 26003
(304) 243-2455
(800) 678-6882

NERAC, Inc.
One Technology Drive
Tolland, Connecticut 06084
(203) 872-7000

Federal Information Exchange, Inc.
555 Quince Orchard Road
Suite 200
Gaithersburg, Maryland 20878
(301) 975-0103

8.0 RESEARCH TOPIC DESCRIPTIONS

SBIR proposals are solicited from the full range of topic areas that follow. Specific subtopics are listed only as **examples** of advanced applications or basic research of interest to USDA and are **not to be interpreted as exclusive**. It is USDA's intention to provide sufficient flexibility to obtain the greatest degree of creativity and innovation possible, consistent with overall SBIR and USDA program objectives. USDA reserves the right to shift proposals to a more appropriate topic when necessary for adequate review.

8.1 Forests and Related Resources

(A) Scope of Research

The objective of this topic is to develop environmentally sound techniques to increase productivity of forest land and to increase the utilization of materials and resources from forest lands. These areas deal with (1) increasing growth and yield through improving planting stock, reducing pathogens and insects, improving the soil or reducing harvesting impacts, and developing means to ensure survival of newly planted trees; (2) increasing the utility of the material grown in the forest through improving lumber yield from trees, utilizing greater percentages of trees, and using residues from forest and wood manufacturing systems; (3) reducing ecological insults

from forest operations; and (4) developing new products or technologies to increase the use of wood.

(B) Suggested Subtopics

Appropriate subtopics for innovative research proposals from small business concerns include, but are not limited to, the following:

(1) Growth and yield

- Improving growing stock, tissue culture, genetic manipulation or vegetative reproduction of forest trees and other means of increasing the regenerative abilities of forests.
- Reducing pathogens and insects - The volume of material lost to disease and insects exceeds that used for lumber and associated wood products. Subjects applicable here are those that reduce the impact of destructive agents.
- Improving soil or reducing harvesting impacts - The fixing of nitrogen by symbiotic agents through genetic manipulation or by mycorrhizae to increase forest

productivity through nitrogen enrichment of forest soils; research to reduce soil erosion, compaction, or other alterations caused by harvesting or forest operations (that is, physical improvement of forest soils).

- Developing systems to increase the survival of newly planted trees through mechanical, physical, or chemical means that are environmentally safe.

(2) Increasing the utility of forest-grown material

- Improving lumber yield or other means of increasing the volume and worth of wood from individual trees.
- Utilizing a greater percentage of the tree through improved or new techniques of veneering or comminution so that new or improved reconstituted products can be made.

(3) Reducing ecological insults by forest operations - Research which provides for the economic recovery of resources from forests while raising potential productivity and reducing impacts to the ecological structure of the area of operation.

(4) Developing new products or technologies to increase the use of wood - Products using wood as a basic component of systems to replace or compete with construction materials or techniques.

8.2 Plant Production and Protection

(A) Scope of Research

The objective of this topic is to examine means of enhancing crop production by reducing the impact of destructive agents, developing effective crop systems that are economically and environmentally sound, enhancing the impact of new methods of plant manipulation, and developing new crop plants and new uses for existing crops. Proposals submitted to this topic will be divided between two review panels, one dealing with biological approaches, and the other dealing with engineering approaches.

(B) Suggested Subtopics

Examples of research activities that would be appropriate for small business concerns include, but are not limited to, the following:

- (1) Plant production** - Improving the efficiency of crop production by utilizing innovative methods such as those of biotechnology, molecular genetics, and tissue culture and embryogenesis; developing improved methods and equipment for planting, growing and harvesting crop plants; and developing new crop plants (both terrestrial and aquatic) as sources of food, fiber or industrial products.
- (2) Plant protection** - Reducing the impact of plant pathogens and insect pests on crop plants; increasing plant resistance to plant pathogens and insect pests; and developing efficient and environmentally safe pesticide and herbicide usage equipment.
- (3) Plant utilization** - Developing new products or technologies to increase the use of major crop plants.
- (4) Energy conservation** - Developing crop management systems, farm structures, and waste utilization for efficient use of energy.

8.3 Animal Production and Protection

(A) Scope of Research

The overall objective of this topic area is to develop knowledge that will enable producers of food animals to increase production efficiency and to assure a reliable, safe supply of animal protein and other animal products while conserving resources and reducing costs of production. Some examples of the areas of research to be supported are: clarification of the nutritional requirements of food animals for improved growth and feed efficiency; determination of hormonal and cellular mechanisms which control reproduction and multiple births; clarification of genetic processes that result in food animals with superior characteristics; improved methods of disposal of animal wastes; and diagnosis, treatment and control of food animal diseases, parasitisms and other animal health hazards.

(B) Suggested Subtopics

Appropriate subtopics for innovative research proposals from small business concerns include, but are not limited to, the following:

(1) Animal Production

- (a) Animal nutrition and digestive physiology** - Research directed at understanding the interrelationships between ali-

mentary microbial ecosystems, digestive processes, and the host animal, and providing nutritional characterization of feedstuffs and integrated nutrient management to enhance production efficiency.

- (b) **Animal reproduction** - Research on the control of estrus, ovulation and fertilization; enhanced embryo survival and development; enhanced parturition and perinatal survival; and advances in embryo technology such as sex control, twinning, frozen embryos and cloning.
- (c) **Animal genetics and breeding** - Studies aimed at germplasm improvement in food animals that will provide animals with superior characteristics in areas such as reproduction, growth and development, lactation and egg production, lean-to-fat ratios, and disease resistance.
- (d) **Livestock management systems** - Development of systems or processes that can be applied to food animal production enterprises that will provide greater efficiency in the production process.

(2) Animal Protection

- (a) **Diagnostic tests** - Development of diagnostic tests for specific diseases and agricultural chemicals which pose a health hazard to food animals and a residue problem in animal food products.
- (b) **Therapeutic methods** - Treatment or treatment methods for acute or chronic health problems of food animals caused by specific infectious or non-infectious agents, parasitisms, chemicals and toxic agents, poisonous plants, injuries and other animal health hazards.
- (c) **Immunization methods** - Vaccines, bacterins or other methods to establish or enhance resistance of food animals to infectious diseases and parasitisms.
- (d) **Pest control strategies** - Development of alternative pest control or eradication methods so as to limit the use of and dependence on biotoxic substances. Such

alternatives may include biological methods, sterile male techniques, artificial pheromones, and similar strategies.

- (e) **Preventive management** - Development of management methods designed to protect food animals against health hazards.
- (f) **Animal health costs** - Development of methodologies to accurately assess economic losses to animal health hazards and to measure economic benefits of alternative methods of prevention and control.

8.4 Air, Water, and Soils

(A) Scope of Research

The objective of this research area is to develop technologies for conserving air, water, and soil resources while sustaining agricultural productivity. This involves developing means to effectively control resources to increase farm and forest productivity as well as the manufacture of resulting commodities.

(B) Suggested Subtopics

Examples of appropriate subtopics for research proposals from small businesses include, but are not limited to, the following:

- (1) Research to reduce losses of soil and soil nutrients or alteration of the physical nature of soil; technologies that enhance soil properties while restricting environmental insults.
- (2) Studies involving reduction of wind-caused erosion of soil; abatement of air pollution stemming from agricultural and forestry enterprises; utilization of air components for agricultural purposes.
- (3) Development of improved methodologies for conserving water resources, restoring water quality, and determining proper irrigation usage to meet current and future agricultural and forestry needs.

8.5 Food Science and Nutrition

(A) Scope of Research

The objectives of food science and nutrition research programs are to develop new knowl-

edge and a better understanding of the characteristics of the foods we eat and their nutritional impact; to apply new knowledge to improve our foods and our diets; and to systematically apply new knowledge to the production of useful new food products, processes, materials and systems, including application of nutritional information to consumer foods and food service systems.

(B) Suggested Subtopics

Research opportunities are many and varied. Areas appropriate for innovative research proposals from small business concerns might include, but not necessarily be limited to, the following:

- (1) **Chemistry and biochemistry** - Novel or rapid assay or bioassay techniques for food constituents, nutrients, properties, or interactions. Quality control techniques or rapid methods for in-plant nutrient analyses are needed.
- (2) **Microbiology and toxicology** - Rapid, efficient methods for determining presence of organisms and detecting the development of toxic metabolites, including systems for determining shelf-life and “pull date” of food items, are needed.
- (3) **Processing** - Methods for automation of processes and tests; rapid analyses and cataloging of physical properties; processing parameters; package design; design of material, energy- and water-efficient processes for small industries; development of specialty products or processes; on-line monitoring and control of nutrient, ingredient, or additive levels.
- (4) **Economics and statistics** - Improved sampling procedures for dry mixes; cost/benefit analyses; and modeling systems, including distribution, warehousing and retailing systems.

8.6 Rural and Community Development

(A) Scope of Research

The objectives of this research area are to foster, promote, or improve the well-being of rural Americans. This program supports research that will result in commercial products or services that are focused on issues and problems related to the economic development and social enhancement of rural areas, small towns, rural people,

rural organizations, and rural institutions. Proposals submitted to this area should not concentrate primarily on the development of new technology, but rather on applying new or existing technology to address important issues and/or solving significant problems of importance to rural America. Proposals that involve development of new technology should explicitly discuss the specific rural problem or opportunity that will be examined, and how this technology will successfully address the problem or opportunity. The proposals do not need to be centered on agriculture, per se, but may be focused on any area (e.g. information systems, education, health care) that has the potential of providing significant benefits to rural Americans.

(B) Suggested subtopics

Examples of appropriate subtopics for research proposals from small businesses include, but are not limited to, the following:

- (1) Application of social science principles to processes that promote or foster **development of income or employment opportunities** in rural areas. Topics in this area may include products or services that enhance availability and capabilities of entrepreneurs, promote innovative ways to organize production systems to increase efficiencies and profitability of rural firms, or stimulate the development of new agricultural enterprises to improve farm profitability.
- (2) Studies that will result in **improvements in service delivery by local governments and public institutions** in rural areas. Areas of interest include educational programs that address the specific needs of people in rural areas, new housing designs that enhance the availability, and affordability of rural housing, improved health care delivery systems for different segments of the rural population, and information and managerial systems that improve the efficiency and effectiveness of local governments.
- (3) Commercialization of technologies that will provide the foundation for **employment and revenue generating opportunities** in rural areas. These technologies could be farm-based to promote more efficient and profitable farming systems or to enhance farm safety, or they could be focused on the gen-

eral needs of rural people in areas such as transportation, telecommunications, waste disposal, and resource management.

8.7 Aquaculture

(A) Scope of Research

The objective of this research area is to enhance the knowledge and technology base necessary for the continued growth of the domestic aquaculture industry as a form of production agriculture. Emphasis is placed on research leading to improved production efficiency and increased competitiveness of private sector aquaculture in the United States. Studies on commercially important (or potentially important) species of fish, shellfish and plants, from both freshwater and marine environments, can be addressed.

(B) Suggested Subtopics

Examples of appropriate subtopics for research proposals from small businesses include, but are not limited to the following:

- (1) **Reproductive Efficiency** - Novel or innovative approaches to improve reproductive efficiency in aquaculture including: greater control of maturation, ovulation, and fertilization; improved gamete and embryo storage; improved larval rearing techniques; enhanced reproductive performance of broodstock; and methods to control sex determination.
- (2) **Genetic Improvement** - Novel or innovative approaches to improve production efficiency through genetic improvement of aquacultural stocks including: genetic mechanisms of sex determination; genetic basis for inheritance of commercially important traits such as growth, cold tolerance and pathogen susceptibility; identification of major genes affecting performance; application of biotechnology and the integration of this technology into breeding programs; basic gene structure and expression in aquatic species; performance evaluation of aquacultural stocks and utilization of crossbreeding and hybridization.
- (3) **Integrated Aquatic Animal Health Management** - Novel or innovative approaches to reducing acute and chronic losses related to aquatic animal health in aquaculture pro-

duction systems through an integrated holistic approach including: physiological stress related to the quality of the aquatic production system; genetic, environmental and nutritional components of aquatic health management; control of predation in aquaculture production systems; development of new vaccines or immunization procedures to enhance resistance to infectious diseases and parasitisms; development of diagnostic tests for specific diseases that pose a health hazard; and development of improved treatment methods for acute or chronic health problems caused by specific infectious or non-infectious agents, parasitisms, injuries, and chemical and toxic agents.

- (4) **Improved Production Systems and Management Strategies** - Novel or innovative approaches to improving existing or alternative production system design and management strategies including: development of biological, engineering and economic design criteria and models; enhancement of water quality in existing production systems through aeration, flow patterns, etc.; characterization, handling and treatment of effluent from aquacultural production systems; improved harvesting methods and strategies.

8.8 Industrial Applications

(A) Scope of Research

The objective of this research area is to develop new or improved technologies that will lead to **increased production of industrial products from agricultural materials**. This research will lead to new opportunities to diversify agriculture and enhance agriculture's role as a reliable supplier of raw materials to industry. Appropriate research areas are: development of new crops that have the potential of producing raw materials that can be converted into useful industrial products; development of procedures for enhanced recovery of critical raw materials from agricultural commodities; development of improved technology for converting agriculturally-derived raw materials into useful industrial products; and development of industrial products derived from agricultural materials to make them more effective and/or more cost competitive with non-agriculturally derived industrial products.

(B) Suggested Subtopics

Examples of appropriate subtopics for research proposals from small businesses include, but are not limited to, the following:

- (1) **Oils and Lubricants** - Development of new agricultural sources of industrial oils and waxes for use as lubricants, cosmetics, soaps and detergents, plastics, paints, and many types of coatings.
- (2) **Natural Rubber** - Improved technology for the production of resin and improvement in the quality of the natural rubber, and research into new applications for bagasse and other co-products.
- (3) **Fuels** - New and improved technology for conversion of agriculturally important biomass material into alcohol and other products to be used as fuel additives and fuel substitutes.
- (4) **Chemicals from Starch** - Development of new products such as absorbants and specialty chemicals from corn and other starchy crops.
- (5) **Fibers** - New and improved technology for production of fiber from kenaf and other promising new fiber crops.

8.9 Marketing and Trade

(A) Scope of Research

The objective of this research area is to identify an array of innovative marketing strategies to increase sales of agricultural, forestry, and aquacultural products (raw commodities, plus processed, value-added food, feed, and industrial products derived from these commodities), both domestically and abroad. This research will assess and evaluate the type, size, and location of market opportunities for specific U.S. products or categories of products; develop specific strategies to gain entry into these markets or expand sales in current markets for specific products or categories of products; identify barriers to trade and develop specific strategies that neutralize these barriers; develop advanced information systems that provide more complete, relevant and timely information relative to temporal marketing opportunities; and develop integrated management systems that would permit maximum efficiencies in assembling, handling, processing, packaging, transporting, and shipping products.

(B) Suggested Subtopics

Examples of appropriate subtopics for research proposals from small businesses include, but are not limited to, the following:

- (1) **Development of Marketing Systems** - Develop post harvest, integrated management systems that take raw, partially processed, or fully processed products and improves the efficiency in assembling, packing, processing, and shipping products to “niche,” regional, national, and international markets. Included in this subtopic would be the development of methods that define strategies to: (a) better integrate collection/assembly systems, (b) minimize seasonal variations in production and processing levels; (c) improve product characteristics through the use of such systems; and, (d) design more efficient packaging, storing, and transportation systems, including intermodal systems.
- (2) **Development of Innovative Real-Time/ Near Real-Time Information Systems** - Develop current and projected economic information on product sales, potential demand, prices, quality standards and specifications, varietal and packaging preferences, and relevant time periods in either real-time, or near-real-time to enable firms to respond more rapidly to national and international marketing opportunities. Also involved in this subtopic would be innovative information products that can inform businesses of the availability, features, and economics of new technologies and innovations, preferably using electronic media with interactive features.
- (3) **Assessments and specification of marketing opportunities** - Identify new national and international markets, or the potential for increasing sales of U.S. forestry, agricultural, and aquacultural products in these markets. Quantify to the extent possible, market characteristics determining demand, product demand, and market structure; other changes relative to consumption patterns at home and abroad; shifts in retail and wholesale marketing; shifts in food manufacturing; and other changes that are relevant to successful marketing.

Agency Disclosure of Estimated Burden

Pursuant to Federal regulations found at 5 CFR 1320.21 pertaining to the Paperwork Reduction Act of 1980, the following information is being furnished on the public reporting burden for the collection of the information required by the following forms: Form CSRS-667 (9.1)—two (2) hours, Form CSRS-668 (9.2)—two (2) hours (OMB Approval No. 0524-0025), Form CSRS-55 (9.3)—one (1) hour, Form CSRS-662 (9.4)—one-half (1/2) hour (OMB Approval No. 0524-0022) and for completing Form CSRS-1234 (9.5)—one-quarter (1/4) hour (OMB Approval No. 0520-0033). This includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding these burden estimates and/or any other aspect of the collection of information, including suggestions for reducing this burden, to the Department of Agriculture, Clearance Officer, OIRM, Ag Box 7630, Washington, D.C. 20250-7630; and to the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, D.C. 20503.

UNITED STATES DEPARTMENT OF AGRICULTURE
SMALL BUSINESS INNOVATION RESEARCH
SOLICITATION NO. USDA / 96-1
PHASE I AND PHASE II
PROPOSAL COVER SHEET

9.1
OMB Approved 0524-0025
Expires 5/98

Proposal No.

Date Received

SUBMITTED BY	Firm			
	Mailing Address			
Project Title				
Topic No. and Area (check appropriate box; see Section 8.0)				
<input type="checkbox"/> 8.1 Forests and Related Resources <input type="checkbox"/> 8.4 Air, Water, and Soils <input type="checkbox"/> 8.7 Aquaculture				
<input type="checkbox"/> 8.2 Plant Production and Protection <input type="checkbox"/> 8.5 Food Science and Nutrition <input type="checkbox"/> 8.8 Industrial Applications				
<input type="checkbox"/> 8.3 Animal Production and Protection <input type="checkbox"/> 8.6 Rural and Community Development <input type="checkbox"/> 8.9 Markets and Trade				
Amount Requested (\$)		Proposed Duration (Mos.)	Congressional District No.	YES NO
1. The above concern certifies that it is a small business firm and meets the definition as stated in this solicitation (See Subsection 2.2).				
2. The above concern certifies that it qualifies as a socially and economically disadvantaged small business as defined in this solicitation (See Subsection 2.4). (For statistical purposes only).				
3. The above concern certifies that it qualifies as a women-owned small business as defined in this solicitation (See Subsection 2.5). (For statistical purposes only).				
4. The above concern certifies that the Principal Investigator's primary employment will be with proposing firm at the time of any resulting award and during the conduct of the proposed research (See Subsection 2.2(c)).				
5. The above concern certifies a minimum of two-thirds of the research will be performed by this firm in Phase I.				
6. Will you permit the Government to disclose the title and technical abstract page of your proposed project, plus the name, address, and telephone number of the corporate official of your firm, if your proposal does not result in an award, to entities that may be interested in contacting you for future information?				
7. Do you plan to send, or have you sent, this proposal or a similar one to any other Federal agency? If yes, give acronym(s); e.g., DOE, NIH, NSF, etc.				
8. Is the organization delinquent on any Federal Debt? (See subsection 5-14(G)). (If yes, attach explanatory information).				
9. Will the work in this proposal involve recombinant DNA, living vertebrate animals, or human subjects? (If yes, complete Form CSRS-662).				
By signing and submitting this proposal, the prospective grantee is providing the required certifications set forth in 7 CFR Part 3017, as amended, regarding Debarment and Suspension and Drug-Free Workplace; and 7 CFR Part 3018 regarding Lobbying. (Please read the Certifications and Instructions included in this solicitation before signing this form.) In Addition, the prospective grantee certifies that the information contained herein is true and complete to the best of its knowledge and accepts as to any grant award, the obligation to comply with the terms and conditions of the Cooperative State Research, Education, and Extension Service in effect at the time of the award. *Submission of the Social Security Number is voluntary and will not affect the organization's eligibility for an award. However, it is an integral part of the CSREES information system and will assist in the processing of the proposal.				
PRINCIPAL INVESTIGATOR			AUTHORIZED ORGANIZATIONAL OFFICIAL	
Name and Social Security Number*			Name	
Title			Title	
Address			Address	
Telephone No.		Fax No.	Telephone No. Fax No.	
Signature		Date	Signature Date	

PROPRIETARY NOTICE (IF APPLICABLE, SEE SUBSECTION 5.4)

The following pages (specify) contain proprietary information which (name of proposing organization) requests not be released to persons outside the Government, except for purposes of evaluation.

For CSRS-667 (4/95)

UNITED STATES DEPARTMENT OF AGRICULTURE
SMALL BUSINESS INNOVATION RESEARCH
PHASE I AND PHASE II
PROJECT SUMMARY*

9.2
OMB Approved 0524-0025
Expires 5/98

FOR USDA USE ONLY

Program Office

Solicitation No.

Proposal No.

Topic No.

TO BE COMPLETED BY PROPOSER

Name and Address of Firm

Name and Title of Principal Investigator(s)

Title of Project (80-character maximum)

Technical Abstract (200-word limit)

Anticipated Results/Potential Commercial Applications of Research (100-word limit)

Keywords to Identify Technology/Research Thrust/Commercial Application (8-word maximum)

*The Project Summary must be suitable for publication by USDA in the event of an award. Do not include proprietary information on this page.

UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE
BUDGET

9.3
OMB Approved 0524-0022
Expires 8/95

ORGANIZATION AND ADDRESS				USDA AWARD NO.	
PRINCIPAL INVESTIGATOR(S)				Duration Proposed Months: _____ FUNDS REQUESTED BY PROPOSER	Duration Awarded Months: _____ FUNDS APPROVED BY CSREES (If Different)
A. Salaries and Wages		CSREES FUNDED WORK MONTHS		\$	\$
1. No. of Senior Personnel		Calendar	Academic	Summer	
a. ___ (Co)-PI(s)					
b. ___ Senior Associates					
2. No. of Other Personnel (Non-Faculty)					
a. ___ Research Associates-Postdoctorate ...					
b. ___ Other Professionals					
c. ___ Graduate Students					
d. ___ Prebaccalaureate Students					
e. ___ Secretarial-Clerical					
f. ___ Technical, Shop and Other					
Total Salaries and Wages →					
B. Fringe Benefits (If charged as Direct Costs)					
C. Total Salaries, Wages, and Fringe Benefits (A plus B) →					
D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.)					
E. Materials and Supplies					
F. Travel					
1. Domestic (Including Canada)					
2. Foreign (List destination and amount for each trip.)					
G. Publication Costs/Page Charges					
H. Computer (ADPE) Costs					
I. All Other Direct Costs (Attach supporting data. List items and dollar amounts. Details of subcontracts, including work statements and budget, should be explained in full in proposal.)					
J. Total Direct Costs (C through I) →					
K. Indirect Costs If Applicable (Specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs included in on/off campus bases.)					
L. Total Direct and Indirect Costs (J plus K) →					
M.					
N. Total Amount of This Request →				\$	\$
O. Cost Sharing (If Required Provide Details)		\$			
<div style="display: flex; justify-content: space-between;"> NOTE: Signatures required only for Revised Budget This is Revision No. → </div>					
NAME AND TITLE (Type or print)		SIGNATURE			DATE
Principal Investigator					
Authorized Organizational Representative					

ASSURANCE STATEMENT(S)

Expires 8/95

STATEMENT OF POLICY - Safeguarding the rights and welfare of subjects at risk and the proper isolation security of research agents in activities supported by Cooperative State Research, Education, and Extension Service is the responsibility of the institution to which support is provided. In order to

provide for the adequate discharge of this responsibility, USDA policy requires a formal assurance that appropriate committees in each institution will carry out both initial review of proposals and continuing review of supported projects. The Department also requires certification of such reviews.

NOTE: Check appropriate statements, supplying additional information when necessary.

1. INSTITUTION	2. TYPE <input type="checkbox"/> New <input type="checkbox"/> Extension <input type="checkbox"/> Revision
	3. CSREES PROJECT NUMBER OR AWARD NUMBER (If Known)
4. TITLE OF PROJECT	5. PRINCIPAL INVESTIGATOR(S)

A. RECOMBINANT DNA OR RNA RESEARCH

- ☐ Project does not involve recombinant DNA or RNA.
- ☐ Project involves recombinant DNA or RNA. (Check the applicable statement).
- ☐ This project has been determined by the local IBC to be exempt from the NIH Guidelines.
 - ☐ This project is under review by the local IBC and a revised Form CSRS-662 will be submitted when the review is completed.
 - ☐ This project has been reviewed by an IBC and was approved on _____ (Date).

This institution agrees to assume primary responsibility for complying with both the intent and procedures of the National Institutes of Health's (NIH) "Guidelines for Research Involving Recombinant DNA Molecules," as revised (see subsection 205(b)(3), Subpart U of the "Uniform Federal Assistance Regulations" (7 CFR Part 3015) and other applicable Federal/State guidelines and regulations.

This responsibility includes:

1. Ensuring that a standing Institutional Biosafety Committee (IBC) reviews proposed projects.
2. Registering with the IBC all experiments involving recombinant DNA and RNA Molecules conducted with the funds provided under this project/ grant and complying with the requirements specified in Part II of the NIH Guidelines or any other pertinent guidelines and regulations. IBC's are required to keep records of this research in a form that is available to the U.S. Department of Agriculture (USDA) upon request.

In addition, principal investigators must report the following to the USDA and to their IBC's:

1. New Technical information relating to risks and safety procedures.
2. Serious accidents or releases involving recombinant DNA or RNA.
3. Serious illness of a laboratory worker which may be project related.
4. Other safety problems.

B. ANIMAL CARE

- ☐ Project does not involve use of vertebrate animals.
- ☐ Project involves use of vertebrate animals. (Check the applicable statement).
- ☐ a) The project is in compliance with the Animal Welfare Act of 1966 and 9 CFR Subchapter A (Laboratory Animals), as amended.
 - ☐ b) This project is under review by the Institutional Care and Use Committee and a revised Form CSRS-662 will be submitted when the review is completed.
 - ☐ c) This project has been approved by the Institutional Animal Care and Use Committee on _____ (Date).

C. PROTECTION OF HUMAN SUBJECTS

- ☐ Project does not involve use of human subjects.
- ☐ Project involves use of human subjects. (Check the applicable statement).
- ☐ a) This project includes activities involving human subjects but can in no way be considered at risk. (If this statement is checked, the person signing this form must also initial in the space at right.) _____ (Initial).
 - ☐ b) This project is under review by an institutional committee as provided by our assurance and a revised Form CSRS-662 will be submitted when the review is completed.
 - ☐ c) This project includes activities involving human subjects. Our institutional committee reviewed and approved it on _____ in accordance with our assurance approved by S&E/and/or DHHS. The project will be subject to continuing review as provided for in that assurance.

SIGNATURE OF AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	TITLE	DATE
---	-------	------

National Environmental Policy Act Exclusions Form

Principal Investigator/Project Director Name	Institution
Address	

Under 7 CFR Part 3407 (CSREES's implementing regulations of the National Environmental Policy Act of 1969 (NEPA)), environmental data or documentation is required in order to assist CSREES in carrying out its responsibilities under NEPA, which includes determining whether proposed research requires the preparation of an environmental assessment or an environmental impact statement, or whether such research can be excluded from this requirement on the basis of several categories. Therefore, it is necessary for the applicant to advise CSREES whether the proposed research falls into one of the following Department of Agriculture or CSREES categorical exclusions, or whether the research does not fall into one of these exclusions (in which case the preparation of an environmental assessment or an environmental impact statement may be required). Even though the applicant considers that a proposed project may or may not fall within a categorical exclusion, CSREES may determine that an environmental assessment or an environmental impact statement is necessary for a proposed project should substantial controversy on environmental grounds exist or if other extraordinary conditions or circumstances are present that may cause such activity to have a significant environmental effect.

Please Read All of the Following and Check All Which Apply

☐ The proposed research falls under the categorical exclusion(s) indicated below:

Department of Agriculture Categorical Exclusions
(found at 7 CFR 1b.3 and restated at 7CFR 3407.6 (a)(1)(i) through (vii))

- ☐ (i) Policy development, planning and implementation which are related to routine activities such as personnel, organizational changes, or similar administrative functions
- ☐ (ii) Activities that deal solely with the functions of programs, such as program budget proposals, disbursements, and transfer or reprogramming of funds
- ☐ (iii) Inventories, research activities, and studies such as resource inventories and routine data collection when such actions are clearly limited in context and intensity
- ☐ (iv) Educational and informational programs and activities
- ☐ (v) Civil and criminal law enforcement and investigative activities
- ☐ (vi) Activities that are advisory and consultative to other agencies and public and private entities, such as legal counseling and representation
- ☐ (vii) Activities related to trade representation and market development activities abroad

CSREES Categorical Exclusions
(found at 7 CFR 3407.6(a)(2)(i) through (ii))

The following categories of CSREES actions are excluded because they have been found to have limited scope and intensity and to have no significant individual or cumulative impacts on the quality of the human environment:

- (i) The following categories of research programs or projects of limited size and magnitude or with only short-term effects on the environment:
 - ☐ (A) Research conducted within any laboratory, greenhouse, or other contained facility where research practices and safeguards prevent environmental impacts
 - ☐ (B) Surveys, inventories, and similar studies that have limited context and minimal intensity in terms of changes in the environment
 - ☐ (C) Testing outside of the laboratory, such as in small isolated field plots, which involves the routine use of familiar chemicals or biological materials
- ☐ (ii) Routine renovation, rehabilitation, or revitalization of physical facilities, including the acquisition and installation of equipment, where such activity is limited in scope and intensity

OR

☐ Proposed research does not fall into one of the above categorical exclusions

(NOTE: If checked, please attach an explanation of the potential environmental impacts of the proposed research. May require completion of an environmental assessment or an environmental impact statement.)

10.0

SAMPLE PROPOSAL FROM USDA SBIR SOLICITATION

This proposal, which resulted in a phase I award, was submitted under the 1988 USDA SBIR Program Solicitation. The sample proposal is provided solely for general guidance. Note, the proposal format specified in this - the 1996 Solicitation - differs from that in earlier solicitations. The budget and current vitae have been omitted and social security numbers have been deleted to protect confidentiality.

U.S. DEPARTMENT OF AGRICULTURE
SMALL BUSINESS INNOVATION RESEARCH
 SOLICITATION NO. USDA/88-1
 PHASE I
 PROPOSAL COVER SHEET

88-00193

APPENDIX A
 OMB Approved 0524-0025
 Expires 6/90

Proposal No. 88-00193
Date Received 10-05-87

8.5

SUBMITTED BY	Firm Bend Research, Inc. <hr/> Mailing Address 64550 Research Road, Bend, Oregon 97701-8599															
Project Title Membrane-Based Process for Debittering Citrus Juice																
Topic No. and Area (check appropriate box; see Section 8.0) <div style="display: flex; justify-content: space-between;"> <div style="width: 48%;"> <input type="checkbox"/> 8.1 Forests and Related Resources <input type="checkbox"/> 8.2 Plant Production and Protection <input type="checkbox"/> 8.3 Animal Production and Protection </div> <div style="width: 48%;"> <input type="checkbox"/> 8.4 Air, Water, and Soils <input checked="" type="checkbox"/> 8.5 Food Science and Nutrition <input type="checkbox"/> 8.6 Rural and Community Development </div> </div>																
Amount Requested (\$) \$49,906	Proposed Duration (Mos.) 6 months															
1. The above concern certifies that it is a small business firm and meets the definition as stated in this solicitation (See Subsection 2.2).	YES X	NO														
2. The above concern certifies that it qualifies as a minority and disadvantaged small business as defined in this solicitation (See Subsection 2.3).		X														
3. The above concern certifies that it qualifies as a women-owned small business as defined in this solicitation (See Subsection 2.4).		X														
4. The above concern certifies that the Principal Investigator's primary employment will be with proposing firm at the time of any resulting award and during the conduct of the proposed research (See Subsection 2.2(C)).	X															
5. Will you permit the Government to disclose the title and technical abstract page of your proposed project, plus the name, address, and telephone number of the corporate official of your firm, if your proposal does not result in an award, to entities that may be interested in contacting you for future information?	X															
6. Do you plan to send, or have you sent, this proposal or a similar one to any other Federal agency? If yes, give acronym(s); e.g., DOE, NIH, NSF, etc.		X														
<table style="width: 100%; border: none;"> <tr> <th style="width: 50%; text-align: center; border-bottom: 1px solid black;">PRINCIPAL INVESTIGATOR</th> <th style="width: 50%; text-align: center; border-bottom: 1px solid black;">AUTHORIZED ORGANIZATIONAL OFFICIAL</th> </tr> <tr> <td style="border: none; padding: 5px;"> Name Dr. Paul van Eikeren </td> <td style="border: none; padding: 5px;"> Name Dr. Walter C. Babcock </td> </tr> <tr> <td style="border: none; padding: 5px;"> Title Director, Biprocess Division </td> <td style="border: none; padding: 5px;"> Title President </td> </tr> <tr> <td style="border: none; padding: 5px;"> Address 64550 Research Road, Bend, OR 97701 </td> <td style="border: none; padding: 5px;"> Address 64550 Research Road, Bend, OR 97701 </td> </tr> <tr> <td style="border: none; padding: 5px;"> Telephone No. (503) 382-4100 </td> <td style="border: none; padding: 5px;"> Telephone No. (503) 382-4100 </td> </tr> <tr> <td style="border: none; padding: 5px;"> Signature <i>Paul van Eikeren</i> </td> <td style="border: none; padding: 5px;"> Signature <i>Walter C. Babcock</i> </td> </tr> <tr> <td style="border: none; padding: 5px;"> Date 9/30/87 </td> <td style="border: none; padding: 5px;"> Date 9/30/87 </td> </tr> </table>			PRINCIPAL INVESTIGATOR	AUTHORIZED ORGANIZATIONAL OFFICIAL	Name Dr. Paul van Eikeren	Name Dr. Walter C. Babcock	Title Director, Biprocess Division	Title President	Address 64550 Research Road, Bend, OR 97701	Address 64550 Research Road, Bend, OR 97701	Telephone No. (503) 382-4100	Telephone No. (503) 382-4100	Signature <i>Paul van Eikeren</i>	Signature <i>Walter C. Babcock</i>	Date 9/30/87	Date 9/30/87
PRINCIPAL INVESTIGATOR	AUTHORIZED ORGANIZATIONAL OFFICIAL															
Name Dr. Paul van Eikeren	Name Dr. Walter C. Babcock															
Title Director, Biprocess Division	Title President															
Address 64550 Research Road, Bend, OR 97701	Address 64550 Research Road, Bend, OR 97701															
Telephone No. (503) 382-4100	Telephone No. (503) 382-4100															
Signature <i>Paul van Eikeren</i>	Signature <i>Walter C. Babcock</i>															
Date 9/30/87	Date 9/30/87															

PROPRIETARY NOTICE (IF APPLICABLE, SEE SUBSECTION 5.4)

FORM CSRS-667 (7/87) For any purpose other than to evaluate the proposal, this data shall not be disclosed outside the Government and shall not be duplicated, used, or disclosed in whole or in part, provided that if a funding agreement is awarded to this proposer as a result of, or in connection with, the submission of this data, the Government shall have the right to duplicate, use, or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in pages 4 through 18 of this proposal.

U.S. DEPARTMENT OF AGRICULTURE
 SMALL BUSINESS INNOVATION RESEARCH
 PHASE I AND PHASE II
 PROJECT SUMMARY*

APPENDIX B
 OMB Approved 0524-0025
 Expires 6/90

FOR USDA USE ONLY			
Program Office SBIR-I	Solicitation No.	Proposal No. 88-00193	Topic No. 8.5
TO BE COMPLETED BY PROPOSER			
Name and Address of Firm Bend Research, Inc. 64550 Research Road Bend, OR 97701-8599		Name and Title of Principal Investigator(s) Dr. Paul van Eikeren Director, Bioprocess Division	
Title of Project (80-character maximum) Membrane-Based Process for Debittering Citrus Juice			
<p>Technical Abstract (200-word limit)</p> <p>A major problem in the citrus industry worldwide is the formation of bitterness in citrus juices within hours after extraction from the fruit. The primary cause of the "delayed bitterness" is the formation of an intensely bitter group of compounds called limonoids, principally limonin and nomilin.</p> <p>Much research has been directed toward finding means to prevent the formation of limonin precursors prior to harvest, as well as finding means to remove limonin after harvesting and processing. However, existing approaches have severe economic, technical, and environmental drawbacks.</p> <p>The proposed program is directed at demonstrating the feasibility of using a novel membrane-based process for the removal and concentration of limonin and nomilin from bitter navel orange juice.</p>			
<p>Anticipated Results/Potential Commercial Applications of Research (100-word limit)</p> <p>Successful development of a membrane system for the removal of limonin from navel orange juice offers a practical procedure for the removal of bitter limonoids from all citrus juices. Furthermore, successful development would provide the basis for fabricating other membranes for the selective removal of off-flavors and off-colors in fruit-juice concentrates. This new process could save the U.S. citrus industry millions of dollars per year.</p>			
<p>Keywords to Identify Technology/Research Thrust/Commercial Application (8-word maximum)</p> <p>Citrus Juice, Limonin, Nomilin, Citrus Bitterness, Debittering</p>			

*The Project Summary must be suitable for publication by USDA in the event of an award. Do not include proprietary information on this page.

21

I. IDENTIFICATION AND SIGNIFICANCE OF THE PROBLEM

Citriculture is an important segment of world food production and nutrition. Oranges account for 67% of total worldwide citrus production. Oranges are consumed, principally in the form of juice, at an annual rate of approximately 17 kilograms per person (The Almanac of the Canning, 1979).

A major problem in the citrus industry worldwide is the formation of bitterness in citrus juice and products within hours after extraction from the fruit. The problem occurs in certain varieties of oranges (including mandarins), grapefruits, and lemons. The problem is estimated to cause losses for California citriculture of \$6 million to \$8 million per year (Anon., 1986a).

The primary cause of the "delayed bitterness" in oranges is the presence of an intensely bitter group of compounds called limonoids, principally limonin and nomilin (Figure 1). The extent of bitterness imparted by limonin has been studied by Levi and coworkers (Levi et al., 1974), who obtained the values shown in Table I.

Much research has been focused on preventing the formation of limonin precursors prior to harvest, as well as on finding means to remove limonin after harvesting and processing. An excellent review of the approaches is given by Hasegawa and Maier (Hasegawa and Maier, 1983), and a summary of recent R&D activities is given in Section V.A. of this proposal. However, existing methods have severe economic and technical limitations (Anon., 1985). Additionally, existing methods often impair the stability and quality of the juice by affecting components other than limonin. Thus, despite extensive research efforts, there is no acceptable commercial method for reducing levels of bitter citrus components. The only current option is to blend excessively bitter juice with non-bitter juice.

The proposed program is directed at demonstrating the feasibility of using a novel process for the removal of limonin and nomilin from bitter navel orange juice. The process is based

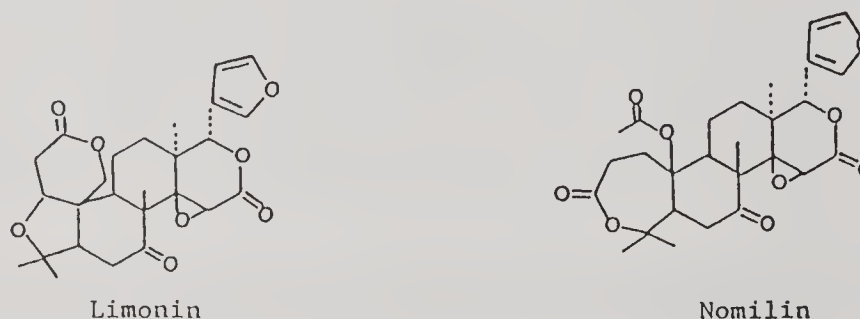


Figure 1. Structure of the Principal Bitter Components in Navel Orange Juice

Table I. Extent of Bitterness with Increasing Limonin Concentration

Concentration of Limonin (ppm)	Extent of Bitterness
<6	Not bitter
6-11	Slightly bitter
12-18	Bitter
>18	Very Bitter

on a membrane that selectively allows the passage of limonin, limonoic acid, nomilin, and nomiloic acid, while retaining desirable flavor and nutritional components. The proposed process is designed so that the juice or concentrate contacts only materials that are accepted for food use or have been shown to be generally recognized as safe. Furthermore, the proposed process promises to be economical on the basis of our preliminary analysis, as is discussed in Section II.C.

II. BACKGROUND, TECHNICAL APPROACH, AND ANTICIPATED BENEFITS

II.A. SOLUTION-DIFFUSION MEMBRANES OFFER A MEANS TO DEBITTER ORANGE JUICE

An attractive approach to the removal of off-flavors (a solute) in fruit juices involves the use of a synthetic membrane that allows the off-flavor to pass through but retains the desired components in the juice. Membranes can be conveniently categorized into two groups (Figure 2): 1) filtration membranes, and 2) solution-diffusion membranes. The more conventional filtration membranes have been studied extensively for food-processing applications, and their limitations are well-known. Those limitations include severe problems with membrane fouling in the application of interest here (Matthiasson, E., 1985). Solution-diffusion membranes, on the other hand, show substantial promise in this type of application.

Filtration membranes contain pores. When a solution is forced through a filtration membrane (convective flow), solute molecules smaller than the pores pass easily; solute molecules larger than the pores are retained. Consequently, the selectivity of this type of membrane is dictated by molecular size. Moreover, a phenomenon known as "concentration polarization"--i.e., the buildup of solutes on the membrane surface--leads to membrane fouling and drastically reduced performance.

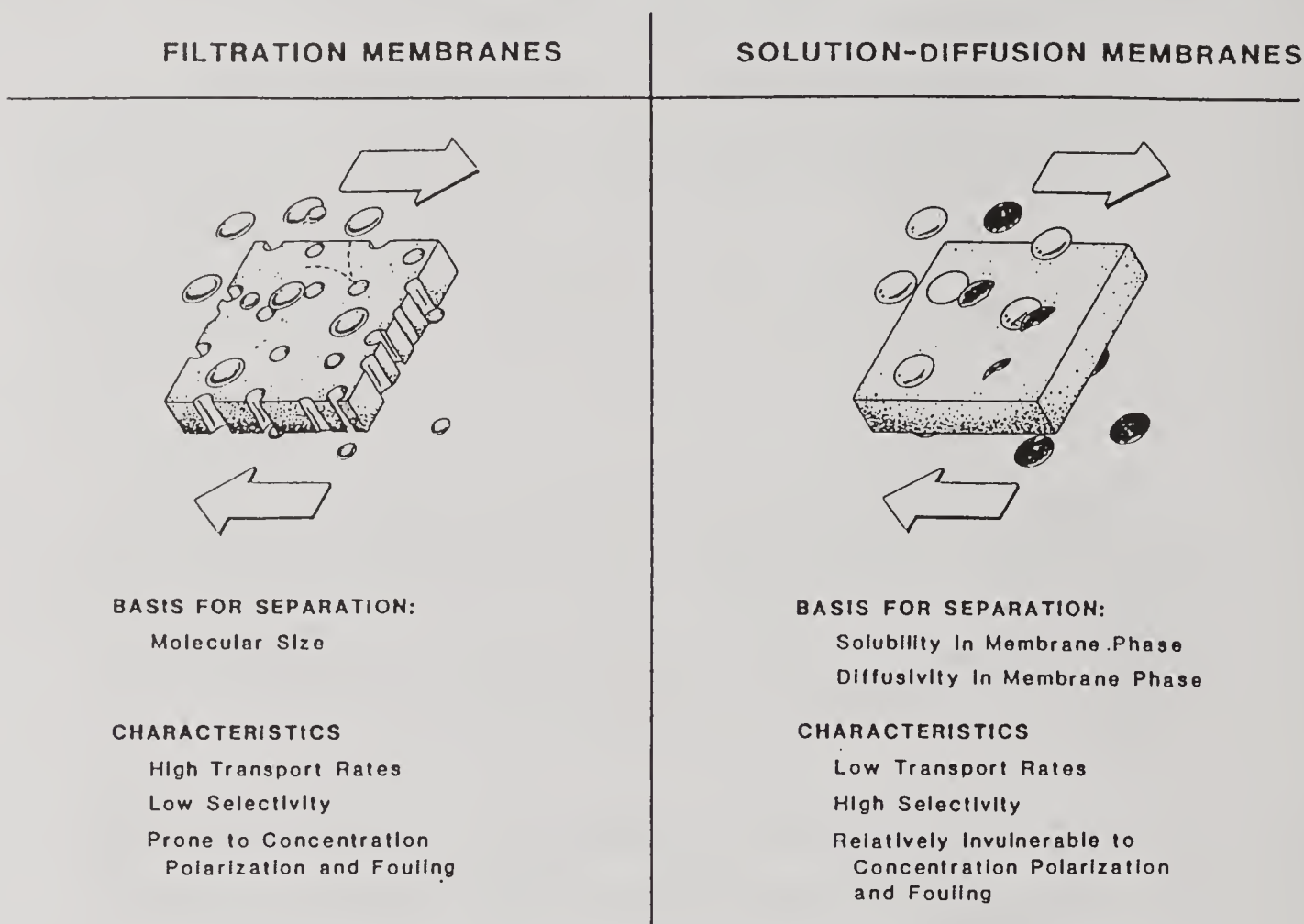


Figure 2. Comparison of Filtration and Solution-Diffusion Membranes

Solution-diffusion membranes do not have pores, and thus there is no convective flow through the membrane. Instead, solute molecules dissolve in the membrane phase and permeate the membrane by molecular diffusion. Molecular solutes that exhibit high solubilities and/or diffusivities in the membrane phase permeate rapidly; molecular solutes that are insoluble in the membrane phase and/or that have low diffusivities are retained. Thus, the selectivity in this type of membrane is closely correlated with solute solubility, and an analysis of this type of membrane parallels liquid-liquid extraction rather than filtration. The key distinction is that, relative to filtration membrane processes, solution-diffusion membrane processes exhibit minimal concentration polarization and consequently resist fouling. This is because solute transport occurs via dissolution in the membrane phase, rather than by convective flow through pores.

In our proposed process, we will use solution-diffusion membranes. Specifically, the membrane consists of a thin layer

of a hydrophobic liquid, about 25 μm thick, that separates two aqueous solutions. The hydrophobic liquid is supported and stabilized within the pores of a microporous, hydrophobic polymer film. Such supported-liquid membranes have been shown in our laboratory to be stable for up to a year, even when separating aqueous solutions that have acid concentrations that differ by ten or more pH units. That degree of chemical stability is critical in the proposed application.

The operation of this type of membrane for the removal of limonin and limonoic acid is illustrated in Figure 3. A feed solution containing orange juice at pH 3.2 flows on the left side of the membrane, and a stripping solution containing aqueous sodium hydroxide at pH 12 to 13 flows on the right side. Limonin from the feed solution dissolves in the hydrophobic supported liquid of the membrane and is transported across the membrane to the strip side by diffusion.

Limonoic acid, produced by the hydrolysis of limonin, is also present in the feed solution. Since the pKa's of limonoic acid are 2.7 and 4.7, at a pH of 3.2--the pH of the juice--one carboxyl group of limonoic acid and a significant fraction of the other carboxyl group are protonated. Thus, limonoic acid, bearing no charges, also dissolves in the hydrophobic supported liquid of the membrane and is transported to the strip side. At the membrane/strip-side solution interface, limonin and limonoic acid dissolve in the strip solution and are rapidly and irreversibly hydrolyzed and deprotonated to limonate under the basic conditions of the strip solution. Since anionic limonate, bearing charges, is insoluble in the supported liquid of the membrane, it cannot back-diffuse; therefore, limonin and limonoic acid are irreversibly transported from the feed solution to the strip solution.

Because limonate is confined to the strip stream, it can be concentrated by using a strip-stream volume that is smaller than the feed-stream volume. The strip-stream volume is reduced by setting the strip-stream flow rate lower than the feed-stream flow rate. From material balance considerations,

$$\text{Limonin Conc. in Strip Stream} = \text{Limonin Conc. in}$$

$$\text{Feed Stream} \times \left(\frac{\text{Feed-Stream Flow Rate}}{\text{Strip-Stream Flow Rate}} \right).$$

*Because the solubility and chemical properties of limonin and nomilin are extremely similar, we believe that the membrane process will operate equally well for nomilin and nomiloic acid. We will therefore use limonin and limonoic acid as a generic terms for all four types of liminoids of interest here.

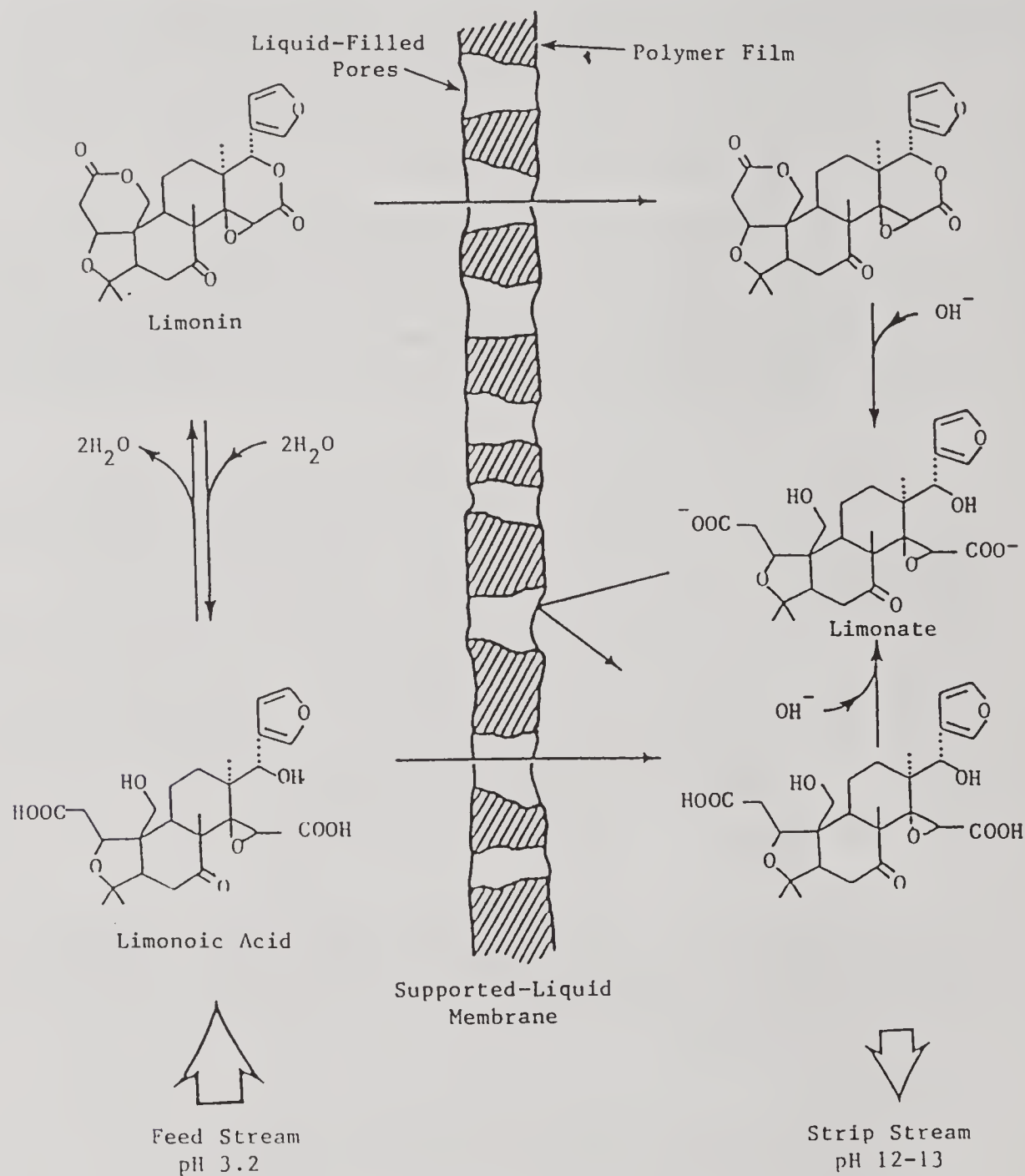


Figure 3. Supported-Liquid Membrane Process for the Removal and Concentration of Limonin from Navel Orange Juice

Hence, the proposed supported-liquid membrane process makes possible the removal and concentration of limonin from orange juice.

II.B. PRELIMINARY EXPERIMENTS SUPPORT THE PROPOSED APPROACH

We have conducted preliminary experiments that indicate that the proposed supported-liquid membrane process efficiently transports limonin and limonoic acid. In a typical experiment, a supported-liquid membrane consisting of Shell Sol 71 supported in the pores of a flat-sheet microporous polypropylene membrane (Celgard 2400 manufactured by Celanese Separations, Inc., Charlotte, NC) was clamped between the two compartments of the membrane-permeability apparatus illustrated in Figure 4. The feed compartment was filled with limonin (60 ppm) dissolved in 20 vol% acetic acid (pH 3.2); the strip compartment was filled with 0.01M aqueous sodium hydroxide (pH 12). The aqueous solutions in the two compartments were stirred and their temperatures maintained at 25°C. The concentration of limonin in the feed compartment was monitored as a function of time by removing aliquots from the feed compartment and assaying the

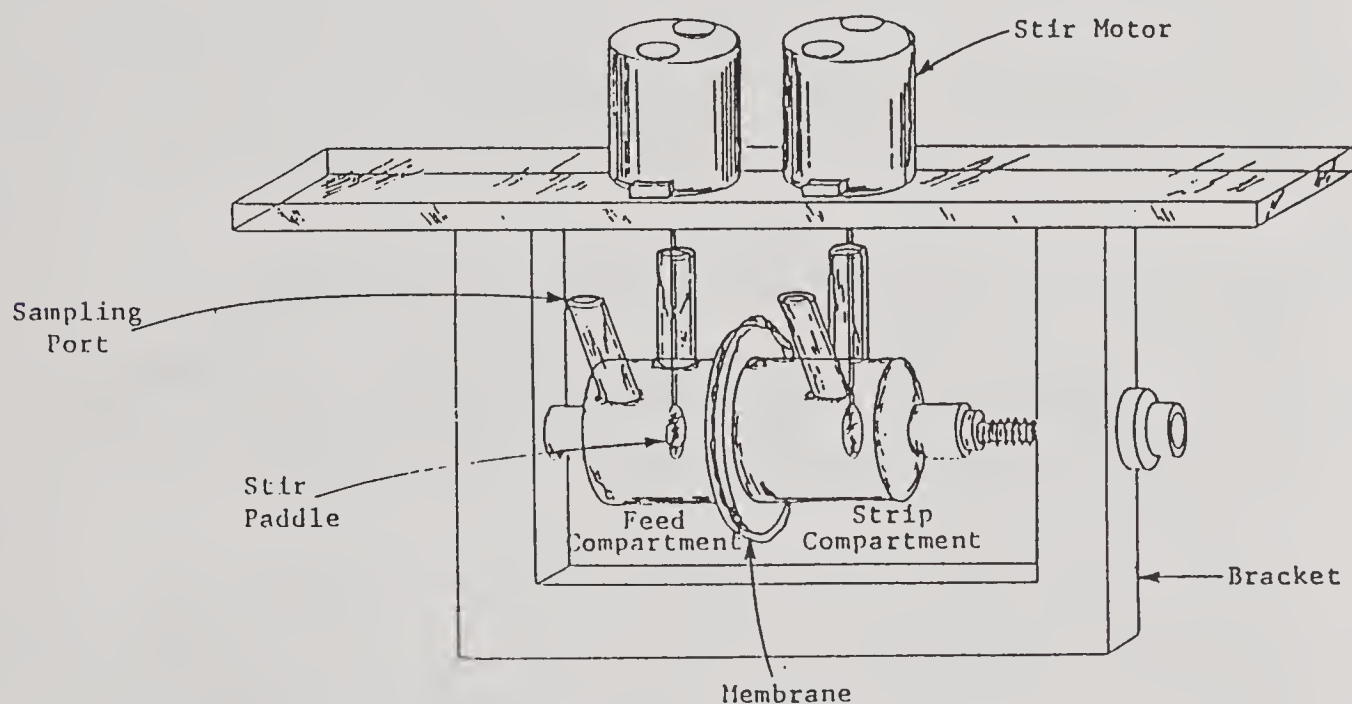


Figure 4. Membrane Permeability Apparatus Used to Test Supported-Liquid Membranes

*Shell Sol is a mixture of aliphatic solvents manufactured by Shell Chemical Company; it is approved for contact with food products.

**Control experiments indicated that the solubility of limonin in water was raised from about 6 to 8 ppm at pH 3.2 to more than 200 ppm at pH 12, presumably due to the base-catalyzed hydrolysis and ionization of limonin.

limonin concentration by means of HPLC and UV detection.⁺ We determined an initial limonin flux⁺⁺ of $2.5 \mu\text{g}/\text{cm}^2\text{-min}$ from the slope of a plot showing limonin concentration in the feed versus time. Dividing the flux by the initial limonin concentration gave a concentration-normalized flux (permeability) of 1.0 cm/hr .

Since limonin in juice exists as a mixture of forms that include limonin and limonoic acid in three possible states of ionization (Chandler and Robertson, 1983), a major concern was whether the membrane could remove all forms of limonin. To address this question we conducted a membrane-based separation experiment on a sample of hydrolyzed limonin. Specifically, limonin (100 ml/L) was suspended in 20 vol% acetic acid and the pH of the suspension was raised to 12 by the addition of sodium hydroxide. Mild heating of the mixture (to 30°C) caused all the limonin to dissolve. The solution was then heated to 65°C to hydrolyze the limonin to limonate. After heating for 30 min, the pH of the solution was adjusted to 3.2 by the addition of concentrated sulfuric acid. The resulting solution (50 ml) was then added to the feed compartment of a membrane-permeability apparatus containing a supported-liquid membrane composed of 30 vol% isohexadecyl alcohol and 70 vol% Shell Sol 71 and a strip solution (168 ml) of pH 12 aqueous sodium hydroxide. The experiment was conducted and analyzed as described previously. The results are shown in Figure 5.

The results shown in Figure 5 make three important statements. One, the membrane process effectively reduces limonin in the feed from about 55 ppm to 11 ppm. Two, the membrane process is effective at removing all forms of limonin, as prior hydrolysis of limonin in the feed has no adverse effect on total limonin removal. And three, the membrane process follows the expected exponential loss of limonin in the feed with a permeability coefficient of 1.1 cm/hr .

The initial results obtained at Bend Research strongly support the validity of the proposed approach. However, the ultimate feasibility on actual orange juice and the favorable economics must be verified via a thorough R&D program designed to identify the optimum membrane materials and operating conditions. The elements of such a program are described in detail in later sections of the proposal.

⁺Limonin was separated from acetic acid on a C18 reverse-phase HPLC column using a 10 vol% to 50 vol% acetonitrile/water gradient and was detected on a diode-array UV detector set at 207 nm. Concentrations were determined from detector response curves obtained using limonin samples of known concentration.

⁺⁺Flux is defined as the amount of material that permeates a given area of membrane in a given time.

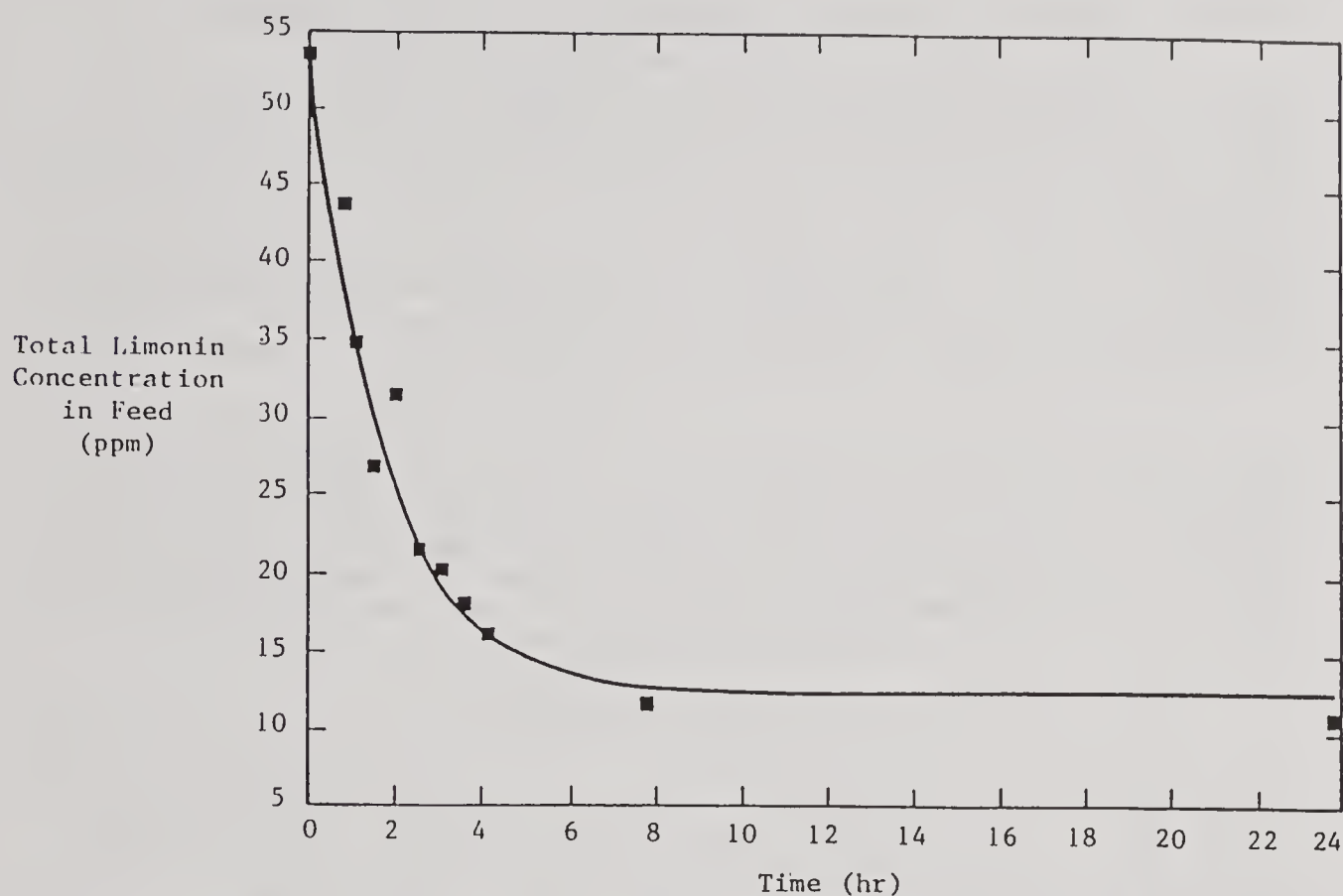


Figure 5. Time Course for the Removal of Total Limonin from the Feed Compartment in the Membrane-Permeability Apparatus. The line is calculated according to Equation $C = C_0 (\exp[-kt])$, where C is the concentration of limonin at any time, C_0 is the initial concentration of limonin, k is a permeability constant of 1.1 cm/hr, and t is time in hours.

II.C. PRELIMINARY COST ANALYSIS SUGGESTS THAT THE PROPOSED PROCESS IS ECONOMICAL

II.C.1. Anticipated Technical Results

In Phase I we will develop a membrane-based process that selectively removes and concentrates limonin. We will incorporate this membrane into a test module and use it to demonstrate the removal of limonin from samples of clarified, very bitter navel orange juice. We will carry out studies to measure the effect of operating parameters on limonin removal, including feed composition, temperature, pH, and feed- and strip-stream flow rates. The results of these studies will be used to make engineering calculations to establish the technical and economic feasibility of the membrane-based limonin-removal process.

II.C.2. Economic Impact of Proposed Debitting Process

The economic impact of "delayed bitterness" in citrus can be illustrated by examining the commercial production of orange juice concentrate in California and Arizona. In a typical year, approximately 40 million pounds of navel orange solids are processed as juice concentrate. Of this amount, approximately 80% would benefit from a debittering process. Juice concentrate that is not bitter sells for approximately \$1.30 per pound of solids. Bitter juice, on the other hand, is discounted a minimum of \$0.20 per pound of solids. Consequently, "delayed bitterness" in navel oranges alone results in an economic loss of at least \$6.4 million in California and Arizona.

The technical objective in Phase I of the proposed program is to develop a process that reduces limonin concentration in orange juice from 40 ppm (a typical value for early-season navel oranges) to 8 ppm. The resulting debittered juice can be mixed with a late-season juice to produce a blend of marketable quality containing less than 6 ppm limonin. A preliminary analysis of the economics of the proposed process is given below.

Given an average concentration gradient across the membrane of 16 ppm limonin, the analysis uses an average limonin flux of 0.29 lb per ft² of membrane per year. This value is based on the permeability values obtained in the preliminary studies reported in Section II.A. We assume that freshly pressed juice contains 11% solids. Equipment and operating costs are based on previously reported metal-recovery studies (Babcock et al., 1983) employing liquid membranes. A list of the assumptions is given in Table II.

The results of our preliminary analysis are shown in Table II. For debittering 32 million pounds of navel orange solids, the total process cost is \$605,940/yr, or 1.9 cents/lb of orange solids. The projected cost compares favorably with the minimum \$0.20-per-lb discount incurred with bitter juice and represents a \$6.1 million potential gain for the citrus industry in California and Arizona alone. Furthermore, it is important to note that in the above analysis the limonin flux used in the calculation is a lower limit that was achieved during very preliminary investigations. Process costs can be further reduced by using thinner membranes or optimized operating conditions to increase limonin flux.

II.C.3. Advantages of the Proposed Debitting Process

The proposed membrane process offers a number of important advantages over existing processes for the removal of limonin:

**Dr. Denny Nelson, Sunkist Research Center, Ontario, California, personal communication

Table II. Preliminary Economic Analysis for Debittering Orange Juice by the Proposed Membrane Process (Based on assumptions by Babcock et al., 1983)

Basis: 32 million pounds of orange solids/yr

<u>Capital Costs (\$)</u>	<u>Cost</u>
Installed membrane and peripheral equipment ($3.21 \times 10^4 \text{ ft}^2 \times \$30/\text{ft}^2$)	963,000
<u>Annual Operating Costs (\$/yr)</u>	
Labor: $\$2/\text{ft}^2$	64,200
Overhead: 2% of installed cost	19,300
Maintenance: 10% of installed cost	96,300
Supported-liquid replacement : 4-month lifetime and $\$1/\text{ft}^2$ replacement cost	96,300
Membrane support replacement: 2-yr lifetime and $\$10/\text{ft}^2$ replacement cost	161,000
Power: $\$0.10/\text{ft}^2$ for pumping cost	3,210
<u>Fixed Costs (\$/yr)</u>	
Capital amortization: 10-yr at 10% interest	156,000
Taxes and insurance: 1% of installed cost	9,630
<u>Total Processing Costs (\$/yr)</u>	
Operating plus fixed costs	605,900
Processing cost of orange solids (\$/lb)	0.019
*As described in Section IV.A., we intend to use supported-liquid membranes in the proposed work.	

- The process can be carried out at low temperature without phase change, thus minimizing deterioration of temperature-sensitive nutritional components in orange juice (e.g., ascorbic acid).
- The process is modular and thus can be operated at any desired scale by simply increasing or decreasing the number of membrane modules used.
- The process can remove limonin from dilute solution and produce it in concentrated form.

- The process can be operated in a continuous mode, thereby minimizing processing time while maximizing process reliability.
- The process is relatively immune to fouling problems that are common when more conventional membrane processes are used in food processing.

Other advantages that we expect to derive from the proposed membrane-based limonin removal process are listed below.

- The process is simple, requiring a minimum of operator control and judgment.
- The process is readily adaptable to sanitary operations.
- The process is designed for high throughput--a condition necessary for large-scale utilization.
- The process will not alter desirable flavor and nutritional components in orange juice or significantly remove them.

II.D. STRUCTURE OF THE PHASED PROGRAM

Phase I is directed at demonstrating the feasibility of using a membrane process to debitter early-season orange juice. Once proof of concept has been accomplished in Phase I, the Phase II effort will focus on 1) optimization of the membrane separation, 2) development of more efficient membranes in hollow-fiber form, and 3) fabrication of prototype hollow-fiber membrane modules. During Phase II, we will do long-term testing of membrane modules under realistic field conditions. The goal is to establish that any adverse effects on module performance caused by sustained operation on actual juice can be rectified in a way that is consistent with large-scale plant operation. It should be noted that the field tests will form the basis for a comprehensive technical and economic evaluation.

If Phase II is successful, we anticipate entering into an agreement with a commercial sponsor for Phase III of the program. Phase III would involve construction of a 1,000-gal/day field-test unit and approximately 12 months (elapsed time) for field-testing and evaluation before full-scale commercialization would

*Although some flavor components are hydrophobic and might permeate the membrane, they are not expected to be concentrated in the strip stream. Recall that limonin is hydrolyzed to limonate dianion in the strip stream and that the net charge on limonate is what prevents its back-diffusion and allows it to be concentrated. Using a ratio of (feed-stream flow rate)/(strip-stream flow rate) = 20/1, there would be--in the worst case--a 5% loss of those flavor components that rapidly equilibrate across the membrane.

be initiated. We anticipate that the membrane modules necessary for Phase III will be fabricated by Consep Membranes of Bend, OR, a manufacturing subsidiary of Bend Research, Inc.

III. PHASE I TECHNICAL OBJECTIVES

The overall goal of this program is to demonstrate the feasibility of using a membrane process to remove and concentrate bitter-tasting limonin from orange juice. We aim to reduce the concentration of limonin in early-season juice from 40 ppm down to 8 ppm so that the purified juice can be mixed with non-bitter, late-season juice to produce a blend of marketable quality (<6 ppm limonin and acceptable flavor).

In pursuit of this goal, we will address the following technical questions:

1. What type of solution-diffusion membrane offers high limonin fluxes and selectivities?
2. How do operating parameters (e.g., flow rate, pH, temperature) affect membrane performance (selectivity and flux)?
3. What is the most effective way to concentrate limonate on the strip side--e.g., high pH, anion-exchange resins, charcoal adsorbers?
4. What is the projected lifetime of the membrane?
5. Does the membrane process alter the flavor or nutritional value of the juice by removing beneficial components?
6. Does the proposed membrane process release materials into the juice that are not accepted for food use or are not generally recognized as being safe?
7. What are the projected economics of the process?

The tasks necessary to answer the above question are detailed in the next section.

IV. PHASE I RESEARCH PLAN

IV.A. TASK 1: SELECTION OF SUPPORTED-LIQUID MEMBRANE

The objective of this task is to identify candidate membranes that transport limonin and limonoic acid but reject limonate. The best candidate membranes will be fabricated and evaluated as described in Tasks 2 through 5.

In this task we will investigate two types of supported-liquid membranes: immobilized-liquid membranes, and liquid-swollen polymer membranes (Figure 6). Immobilized-liquid membranes consist of a hydrophobic liquid held in the pores of a microporous support. Liquid-swollen polymer membranes consist of dense polymer membranes that have been swollen by hydrophobic liquids.

Our approach to selecting candidate supported liquids is guided by the principle that high limonin and limonoic acid transport is associated with high limonin and limonoic acid solubility in the supported liquid of the membrane. Thus, by employing solubility and distribution-coefficient data, we aim to identify supported liquids that exhibit high limonin and limonoic acid solubilities but low solubilities to desirable flavor and nutritional components. We will use ascorbic acid as a representative desirable nutritional component, linalyl anthranilate (essence of orange) as a representative desirable flavor component, and a 0.1M (pH 3.2) citric acid solution containing 12 wt% sucrose as a synthetic orange juice base. We will then measure the distribution coefficient of limonin, ascorbic acid, and linalyl anthranilate between the synthetic orange juice base and a number of hydrophobic liquids. Candidate liquids include high-molecular-weight even-numbered straight-chain alcohols. For example, 1-decanol has low water miscibility and is essentially nonvolatile. Liquids will be ranked on the basis of their tendencies to preferentially partition limonin and limonoic acid.

Limonin and limonate concentrations will be determined by HPLC analysis as described in our summary of preliminary experiments (Section II.A.) and as reported by Shaw and Wilson

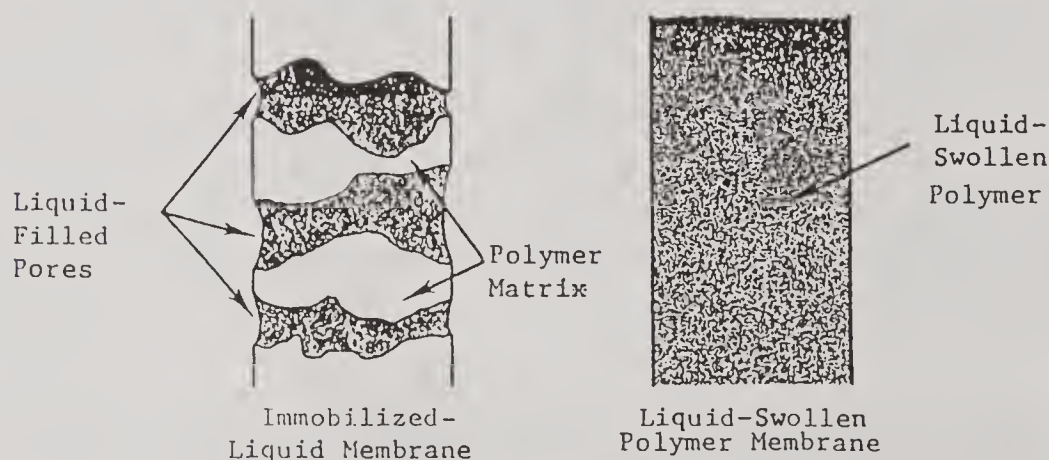


Figure 6. Types of Supported-Liquid Membranes

*We have chosen even-numbered alcohols because they are approved for some food-separation processes.

(Shaw and Wilson, 1984). Ascorbic acid concentrations will be determined by the reduction of Fe(III) by the ascorbic acid and subsequent measurement of the absorbance of Fe(II)-ferrozine chelate at 562 nm as described by Taselskis and Nelapaty (Taselskis and Nelapaty, 1972). Linalyl anthranilate concentrations will be determined by HPLC analysis.

IV.B. TASK 2: MEMBRANE FABRICATION AND TESTING

During the proposed Phase I feasibility study, we will study only flat-sheet membranes, as they are easy to fabricate and they can be readily evaluated in our membrane-permeability apparatus (Figure 4). However, we plan to use hollow-fiber membranes in Phase II development work because of their higher surface-area-to-volume ratio. It is our experience that developments obtained with flat-sheet membranes are readily transferable to hollow-fiber membranes.

Immobilized-liquid membranes will be prepared by sorbing the solvents selected in Task 1 into the pores of a microporous membrane. We intend to examine the feasibility of using Goretex Type S 11003 (polytetrafluoroethylene), Celgard (microporous polyethylene), and BRI's microporous polysulfone and microporous polyvinylidene difluoride as supports for the liquid membranes. The immobilized-liquid membranes will be prepared by immersing the microporous support in the solvent and removing the air bubbles remaining in the pores by repeatedly drawing and releasing a vacuum above the solvent. The organic liquid is retained in the pores by capillarity.

Liquid-swollen polymer membranes are prepared by immersing the polymer membrane in the selected liquid with gentle warming. Polymer membranes will be obtained as commercial membranes or prepared as films supported on porous backings by using one of the following methods: 1) casting a solution of the polymer dissolved in an organic solvent onto a preformed porous support, such as polysulfone, and letting the membrane air-dry to form a thin, nonporous film on the support; 2) forming a supported-polymer membrane by casting the polymer solution onto a glass plate and then precipitating the polymer in water; or 3) laminating a precast polymer membrane onto a preformed porous support by heating, such that the polymer membrane melts just enough to be "heat sealed" onto the support. These membrane-fabrication techniques have been successfully used at Bend Research for a variety of membranes, and thus we expect the probability of success in this task to be very high.

The supported-liquid membranes will be tested to ascertain that they are free of leaks by measuring initial fluxes of ascorbic acid in a membrane-permeability apparatus of the type illustrated in Figure 4. Defect-free supported membranes are expected to display high resistance to ascorbic acid transport. We will also measure initial fluxes of limonin and limonate. Initial fluxes will be determined by imposing a concentration

gradient across the membrane and periodically removing and analyzing samples of the solution on the permeate side of the test cell as described in Section II.A. Permeabilities will be calculated using the relationship

$$\text{Permeability} = (\text{Permeate Flux}) / (\text{Concentration Difference}).$$

Selectivities will be calculated relative to ascorbic acid permeability using the relationship

$$\text{Selectivity} = (\text{Limonin Permeability} / \text{Ascorbic Acid Permeability}).$$

IV.C. TASK 3: OPTIMIZING STRIPPING CONDITIONS

Limonin fluxes are governed, in part, by the limonin-concentration gradient across the membrane. Thus, effective limonin removal hinges on maintaining low concentrations of membrane-permeable forms of limonin in the strip side. This can be accomplished by transforming all limonin forms to limonate, or adsorption of limonin forms onto adsorbents. In this task we will measure the solubility of limonin as a function of strip-solution pH (in the range of 10 to 13) and temperature (in the range of 25° to 65°C). Additionally, we will study the use of commercially available, strong anion-exchange resins (e.g., Dowex 1-X2, Amberlite IR-401, Duolite ES-861) and activated carbon (e.g., Darco) as a means to adsorb and concentrate limonin forms in the strip solution.

IV.D. TASK 4: MEMBRANE PERFORMANCE WITH CLARIFIED ORANGE JUICE

On the basis of limonin flux and selectivity, we will select the two best supported-liquid membranes prepared in Task 2 and the best stripping conditions determined in Task 3 for evaluation on actual orange juice. A test module that holds a 1-ft² section of flat-sheet membrane will be fabricated for this task. To eliminate problems associated with handling orange juice pulp, we will carry out our Phase I membrane-performance studies on clarified orange juice. During Phase II we would design a system that would treat all components of orange juice concentrate.

To aid us in this task, we have established a collaboration with Dr. Denny Nelson of the Sunkist Research Center in Ontario, California. Dr. Nelson has provided us with authentic samples of limonin and will provide us with clarified early-season navel orange juice containing 30 to 40 ppm limonin. Furthermore, he has offered to test the purified juice for bitterness removal, as well as nutrient and flavor loss. Additionally, we will test the purified juice for the presence of materials released from the membrane. If any major difference in membrane performance is evident when actual clarified juice is used as compared with performance when a synthetic mixture of limonin, ascorbic acid and linalyl anthranilate is used, an attempt will be made to determine the cause.

IV.E. TASK 5: EFFECT OF OPERATING CONDITIONS ON LIMONIN REMOVAL

The objective of this task is to measure the effect of operating conditions on the efficacy of limonin removal from clarified orange juice. Operating parameters to be considered include temperature, feed- and strip-stream velocity across the membrane, pH of the strip stream, and composition of the feed stream.

Liquid membranes similar to those to be used in the program but applied to inorganic-salt separations are known to perform adequately for 6 months without requiring reloading with fresh organic solution. Liquid-swollen membranes are known to perform adequately for up to 2 years. However, such membranes have not been evaluated for limonin removal from citrus juice. Hence, the additional purpose of this task is to run limited (about 1 month) lifetime studies using clarified orange juice to be certain that there are no short-term adverse effects on membrane life.

IV.F. TASK 6: PRELIMINARY TECHNICAL AND ECONOMIC ANALYSIS AND PREPARATION OF FINAL REPORT

In this task we will make use of the data obtained in Tasks 4 and 5 to perform a technical and economic evaluation. These evaluations will form the basis of the decision to proceed into the Phase II program. The results will appear in our final report.

V. RELATED RESEARCH AND DEVELOPMENT

V.A. R&D ACTIVITIES RELATED TO PROPOSED EFFORT

Previous approaches to bitterness reduction in citrus products fall into three categories: 1) preharvest treatments that inhibit the formation of limonoids in citrus fruits, 2) biotransformation of bitter limonoids into non-bitter metabolites, and 3) limonoid removal by adsorption on polymer resins. However, none of these approaches has been put into commercial practice. A brief discussion of recent R&D activities in these three categories follows.

Shin Hasegawa from the Fruit and Vegetable Chemistry Laboratory of the Department of Agriculture's Agricultural Research Service in Pasadena, California has recently reported a preharvest treatment that claims to inhibit the formation of limonoids in citrus fruit (Anon., 1986b). The treatment consists of applying synthetic auxins (plant-growth regulators) that are potent inhibitors of limonoid biosynthesis. However, this approach has not been demonstrated to be cost-effective.

Several investigators have reported studies directed at using biotransformations as a means to avert bitterness by converting bitter limonoids in citrus juice to non-bitter

metabolites. Approaches include the use of immobilized cells (Hasegawa et al., 1983; Hasegawa and Pelton, 1983) and the use of enzymes (Hasegawa, 1975a; Hasegawa, 1975b). A drawback of these approaches is the deterioration of the flavor and color of treated juice.

Most R&D activities have been directed at removing bitter limonin from juice by adsorption or complexation on polymer adsorbents. Approaches include the use of ion-exchange resins (Coca-Cola Co., 1987; Mitchell et al. 1985; Johnson and Chandler, 1985; Puri, 1984), cyclodextrin polymers (Shaw et al., 1984), and cellulose ester gels (Johnson and Chandler, 1981a; Johnson and Chandler, 1981b, and Chandler and Johnson, 1979). These approaches, however, have a number of shortcomings, including unfavorable process economics, excessive process complexity requiring extensive operator control, the need for organic solvents to strip limonin from the adsorbent, and production of difficult-to-manage waste streams.

V.B. BEND RESEARCH ACTIVITIES RELATED TO THE PROPOSED EFFORT

Bend Research is currently involved in several separate but related membrane-based separation projects. Dr. Paul van Eikeren, the principal investigator, is currently directing an NSF SBIR Phase II project entitled, "Optical Resolution of D,L-Phenylalanine in a Membrane Reactor" that is focused on using supported-liquid membranes to selectively remove the product of an enzyme-catalyzed reaction. Additionally, he is directing several proprietary projects for private Bend Research clients directed at using membrane separations to recovery valuable food additives and flavoring agents.

VI. KEY PERSONNEL AND BIBLIOGRAPHY

It is anticipated that Dr. Paul van Eikeren will serve as principal investigator, with key contributions being made by Dr. Harold Lonsdale. Dr. van Eikeren has extensive R&D experience in areas directly related to the proposed work. He is now directing several Phase I and Phase II SBIR programs. Dr. Lonsdale has 25 years of experience in the field of membrane technology and is recognized internationally as a leader in the field. He is the founding and current editor of the Journal of Membrane Science. Abbreviated resumes for these individuals follow.

VII. FACILITIES AND EQUIPMENT

Bend Research is a 10,000-ft² laboratory and office complex; an additional 5,000 ft² is under construction. The firm employs a technical staff of 45 and has 70 employees. Work is devoted exclusively to the development of membranes and membrane-based processes. In-house material and equipment relevant to the performance of the proposed program include the following:

- a) atomic absorption, UV-visible, and FT-IR spectrophotometers;
- b) multiple HPLC and GC instruments;
- c) scanning electron microscope;
- d) organic-synthesis laboratory and capability;
- e) continuous-production equipment for flat-sheet and hollow-fiber support membranes; and
- f) membrane-permeation apparatus.

VIII. CONSULTANTS

Dr. Denny Nelson, Director of R&D at Sunkist Research Center, Ontario, California, is an expert in the field of debittering navel orange juice. He has agreed to consult with Bend Research on this project without compensation.

IX. POTENTIAL COMMERCIAL APPLICATIONS

Successful development of a membrane system for the removal of limonin offers a practical procedure for the removal of bitter limonoids from all citrus juices. Furthermore, successful development would provide the basis for fabricating other supported-liquid membranes for the selective removal of off-flavors and off-colors in fruit-juice concentrates. For example, supported-liquid membranes could offer a means of removing polyphenol off-colors in natural sweeteners produced from apple or pear concentrates.

X. CURRENT AND PENDING SUPPORT

No work substantially similar to that proposed here is being conducted at this time, nor is any pending.

XI. EQUIVALENT PROPOSALS

No proposal substantially similar to this has been submitted to any other agency.

REFERENCES

- Anon., "New Methods Remove Citrus Bitterness," C&E News, May 27(1985)58.
- Anon., "Method to Reduce Bitterness in Citrus Found," C&E News, October 27(1986a)25-26.
- Anon., "Method to Reduce Bitterness in Citrus Fruit," C&E News, October 27(1986b)25.
- Babcock, W.C. et al., Renovation of Printed Circuit Board Etchants with Coupled Transport Membranes. Final report to the National Science Foundation from Bend Research, Inc. on Grant No. DAR-8023179, November 17, 1983.
- Chandler, B.V., and G.L. Robertson, "The Solubility of Limonin, the Bitter Principle of Orange Juice," J. Sci. Food Agric., 84(1983)1272-1284.
- Chandler, B.V., and R.L. Johnson, "Adsorbent Materials for Debittering Citrus Juices," Australian Patent 498,130, February 15, 1979.
- Coca-Cola Co., "Method of Reducing Bitterness in Citrus Fruit Juices," Israeli Patent 70634 AL, January 30, 1987.
- Hasegawa, S., and V.P. Maier, "Solutions to the Limonin Bitterness Problem of Citrus Juices," Food Techn., 37(1983)73-77.
- Hasegawa, S. et al., "Metabolism of Limonoids by *Arthrobacter Globiformis* II: Basis for a Practical Means of Reducing Limonin Content of Orange Juice by Immobilized Cells," J. Agric. Food Chem., 31(1983)1002-1004.
- Hasegawa, S., and V.A. Pelton, "Reduction of Nomilin Bitterness in Citrus Juices and Juice Serum with *Arthrobacter Globiformis* Cells Immobilized in Acrylamide Gel," J. Agric. Food Chem., 31(1983)178-180.
- Hasegawa, S., L.C. Brewster, and V.P. Maier, "Limonate:NAD(P) Oxidoreductase and Debittering of Citrus Juices and Other Products," U.S. Patent 3,920,851, November 18, 1975a.
- Hasegawa, S., L.C. Brewster, and V.P. Maier, "Limonate:NAD(P) Oxidoreductase Manufacture and Use in Prevention of Bitterness in Citrus Juice," U.S. Patent 3,917,512, November 4, 1975b.
- Johnson, R.L., and B.V. Chandler, "Ion Exchange and Adsorbent Resins for Removal of Acids and Bitter Principles from Citrus Juices," J. Sci. Food Agr., 36(1985)480-484.
- Johnson, R.L., and B.V. Chandler, "Reactivation of Cellulose Acetate Gel Bead Column Used for the Removal of Limonin from Citrus Juices," J. Sci. Food Agr., 32(1981a)1191-1196.
- Johnson, R.L., and B.V. Chandler, "A Pilot-Plant Cellulose Acetate Gel Bead Column for the Removal of Limonin from Citrus Juices," J. Sci. Food Agr., 32(1981b)1183-1190.

Levi, A., et al., Lebensm.-Wiss. Technol., 7 (1974)234-235.

Matthiasson, E., "Fouling in Membrane Filtration," in Fouling and Cleaning in Food Processing, D. Lund, B. Hallstrom, E. Plett, C. Sander, and C. Tragardh (eds.). University of Wisconsin-Madison Duplicating, Madison, Wisconsin (1985).

Mitchell, D.H., R.M. Pearce, C.B. Smith, and S.T. Brown, "Removal of Bitter Naingin and Limonin from Citrus Juices Containing Them," U.S. Patent 4,514,427, April 30, 1985.

Puri, A., "Citrus Juices, Concentrates, and Dried Powders Which Are Reduced in Bitterness," U.S. Patent 4,439,458, March 27, 1984.

Shaw, P.E., J.H. Tatum, and C.W. Wilson, "Improved Flavor of Novel Orange and Grapefruit Juices by Bitter Components with β -Cyclodextrin Polymer," J. Agr. Food Chem., 32(1984)832-836.

Shaw, P.E., and C.W. Wilson, "A Rapid Method for Determination of Limonin in Citrus Juices by High Performance Liquid Chromatography," J. Food Sci., 49(1984)1216-1218.

Taselskis, B., and J. Nelapaty, "Spectrophotometric Determination of Microamounts of Ascorbic Acid in Citrus Fruits," Anal. Chem., 44(1972)379-381.

The Almanac of the Canning, Freezing, Preserving Industries, E. Judge and Sons, Westminster, Maryland (1979) p. 576.

PVE/kp
96a:Debittr^

The United States Department of Agriculture (USDA) prohibits discrimination in its programs on the basis of race, color, national origin, sex, religion, age, disability, political beliefs and marital or familial status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact the USDA Office of Communications at 202-720-5881 (voice) or 202-720-7808 (TDD).

To file a complaint, write the Secretary of Agriculture, U.S. Department of Agriculture, Washington, D.C., 20250, or call 202-720-7327 (voice) or 202-720-1127 (TDD). USDA is an equal employment opportunity employer.

CSREES-OGPS-AMD-PSB
AG Box 2245, Aerospace Center
UNITED STATES
DEPARTMENT OF AGRICULTURE
WASHINGTON, D.C. 20250-2245

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, \$300

Ag Box 2245 (CSRS) P

Joseph H. Howard
Director
National Agricultural Library
U.S. Dept. of Agriculture
Room 200
Beltsville, MD 20705

Collection